THE ENGINEER.

Reciprocating Machine Tools.

RECIPROCATING MACHINE TOOLS.

We have selected for the subject of our Supplement this autumn that class of machine tools that may be defined as reciprocating or straight cut. Machines of this type are of at least equal importance with lathes, milling machines, and drills, but for one reason and another they seem to have received, so far, less attention. Of them, both on account of its size, its age, and its importance, the planing machine holds first place. After it comes the slotting machine proper, which, for a certain class of work, is as unapproachable as the planer; and, finally, the shaping machine, a tool which rarely reaches very striking dimensions. There are, of course, various other straight-line machines, key-way seaters and gear shapers, for example, designed for special purposes; but they are all fairly well covered by the three great classes we have named.

To the vee bed, invented, we believe, by Clements, and the construction of which even at the present is recognised as presenting many difficulties, the development of the planer owes a great deal. It is now, indeed, being superseded, but for many years it was the recognised design. Well made, it is practically ideal in all respects save one. It holds the table absolutely rigid sideways, it adjusts itself automatically, and it does not readily collect chips or dirt. In only one respect is it open to objection—leaving the difficulties of manufacture out of account—and that is in the matter of lubrication. It is obviously less easy to oil an inclined surface than a horizontal one, and although the elegant device that is now universally employed for this purpose—the oil rollers—diminish the objection, they do not obliterate it wholly, since there is a tendency for conical rollers to wear out of truth, due to differences in diameter, and to cease to do their work thoroughly. It may be very truly said that the venerable age of planers which are still doing good work is a positive evidence to the efficiency of the vee bed—that is undeniable. But conditions in the machine shop are changing with great rapidity. Not many years ago 15ft. or even less per minute was looked upon as a good cutting speed for a planing machine. Now 35ft. to 45ft. per minute are speeds of cut which become rarer as our knowledge increases, whilst a return speed of 120ft. or even 140ft. per minute—more than twice what it used to be—is occasionally used. Wear and tear are not directly proportional to speed, but to some higher power, and hence an argument that had not very great weight some twenty—even ten—years ago has grown in importance. But there is more than this matter of lubrication. With increasing competition the necessity for cheap production has increased enormously. Now, there can be but little question that a good flat bed is produced more easily than a vee bed of equal accuracy. It is true that a slight inaccuracy in an inclined surface supporting a vertical load has less effect than an inaccuracy of the same amount in a horizontal surface; but the advantage is not sufficient to compensate for the great difficulties of getting two long vees truly parallel and without wind, and therefore the days of the vee bed are probably numbered. But since it has the undoubted advantage that it holds the table sideways better than any other device yet invented it is not willingly given up, and more than one maker has attempted a compromise by making one side of this form whilst the other is made flat. It is doubtful if the arrangement is commendable, because there is some uncertainty as to the equality of the wear on both sides. The design certainly has not met with general favour, and it may be safely said that the flat bed is the bed of the future. It has very obvious points in its favour. In the first place, it can be produced with but little difficulty. It is an easy matter to lay a straight edge along a flat bed and winding strips across it, and in putting the machine on its foundations a good surface for the spirit level is afforded. Moreover, it presents an excellent surface from which the standards, the cross slides, and so on can be set, and, in fact, it facilitates in no small degree the fitting and erection of the machine. On top of all this we have the fact that it can be lubricated with such ease and certainty that the objection that chips and dust may lie upon it has little or no weight. In the pages that follow planers by many makers are illustrated, and it will be observed that in a good number of cases the vee bed has been given up.

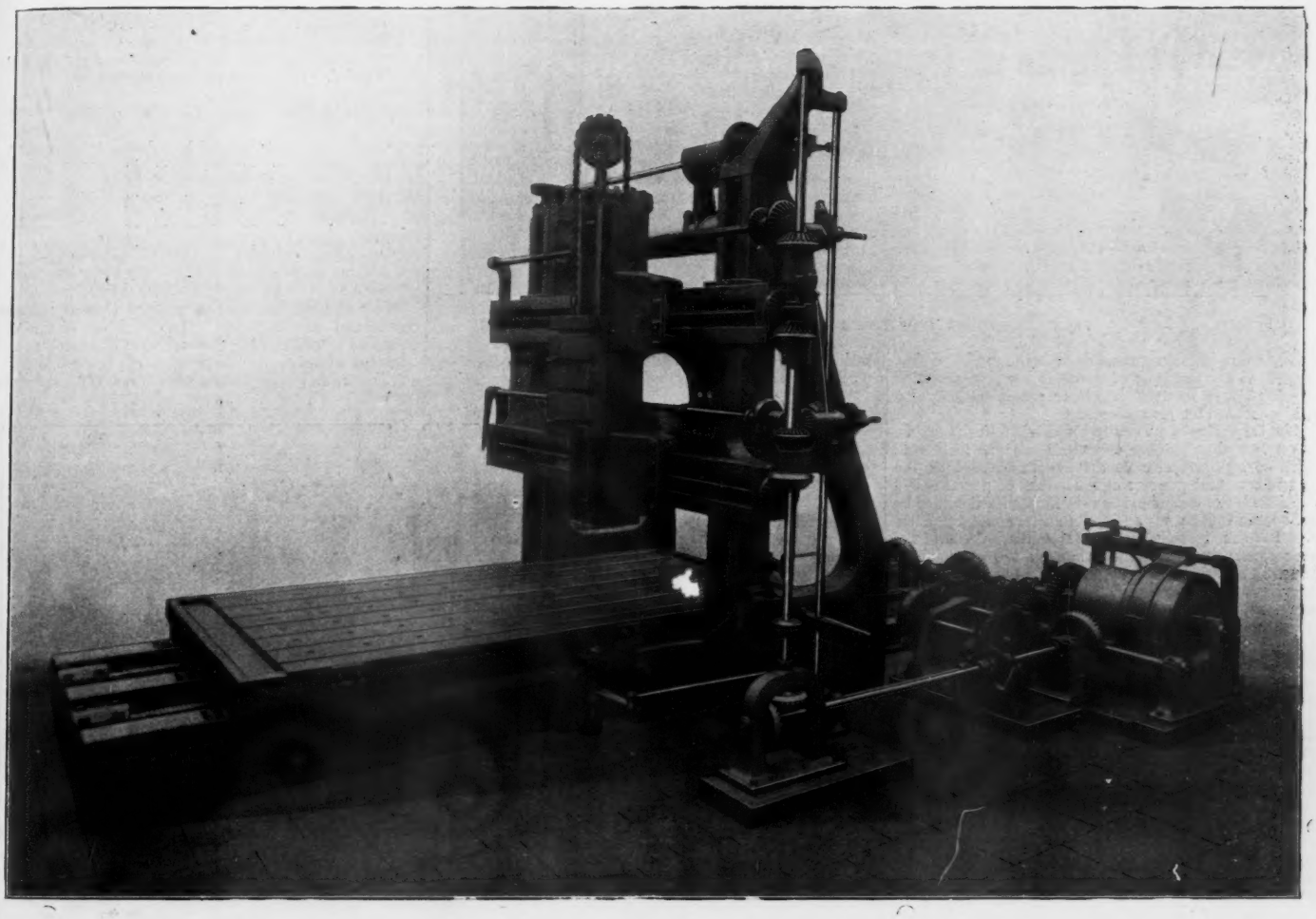


Fig. 1—HULSE'S ARMOUR-PLATE PLANING MACHINE

No question has aroused more discussion amongst engineers than the power absorbed in the reversal of a planer table. It is well known that the energy demanded at the instant of reversal is several times greater than that needed for the cut, hence the planer is regarded, and in a sense correctly, as an extravagant machine. Some years ago we published a series of instructive diagrams taken by Capt. Tresidder at John Brown and Co.'s works. The article appeared in our issue of March 23rd, 1900, and was accompanied by a supplement, in which were reproduced ammeter records taken during machining.

These diagrams were taken with recording ammeters, and as the results are regarded as particularly trustworthy, a brief account of them in this Supplement will not be out of place. The motors employed were of the enclosed type, working at 220 volts. Their estimated efficiency was 85 per cent. Raw hide pinions were mounted on their armature shafts and drove steel spur gearing, which was belted direct to the planers. The material to be machined was a very tough steel, with a breaking strain of from 45 to 60 tons per square inch. With this material much less power can be put into the tool than in the case of ordinary engineering work, as the limit is not in the strength of the tool or machine,

but in the edge-holding power of the tool steel. It has been found desirable, for instance, to have the ploughing

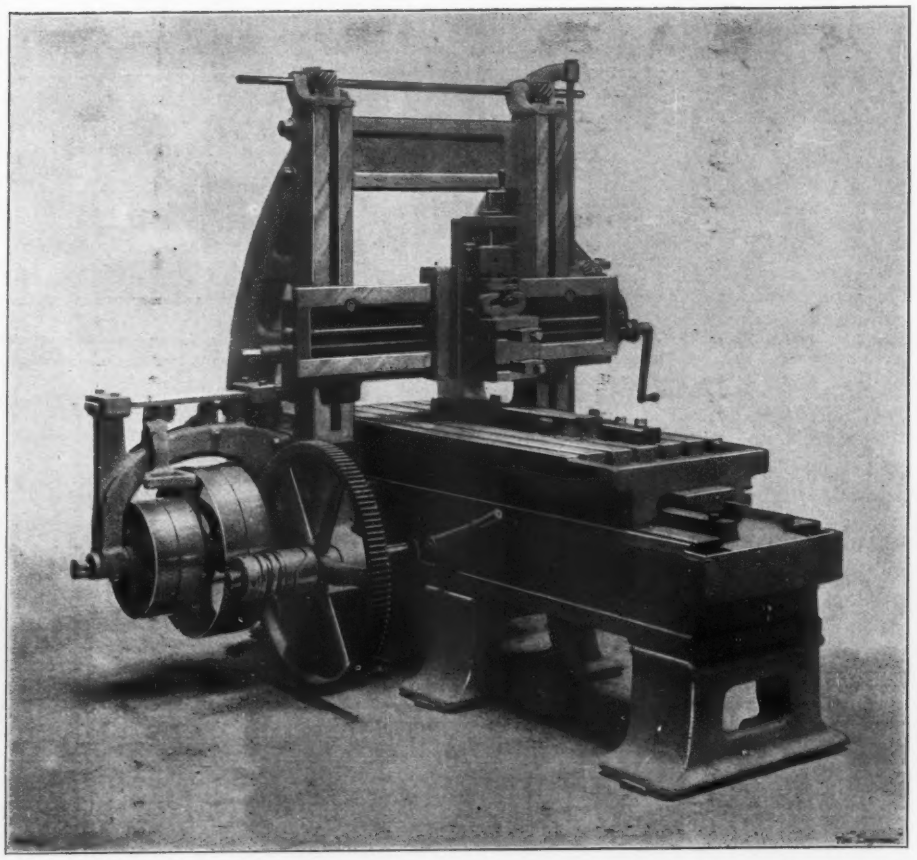


Fig. 2—SMITH AND COVENTRY'S PLANING MACHINE

feed of planing machines capable of being made as fine as 200 traverses per inch of feed—in some cases it is finer—and 1in. in about 80 or 100 traverses cannot, as a rule, be exceeded for ploughing.

Incidentally, Captain Tresidder remarked in the article under notice that planing machines are the least well adapted to separate electric driving on account of the large and constantly recurring variations of power called for. At each reversal considerable momentum has to be absorbed, and then re-initiated in the contrary direction. In the installation at John Brown's, all the driving shafts are so arranged that, by the omission or insertion of a few coupling bolts, they can be made either independent or otherwise. The idea was that if the separate motors could be run in parallel—which the manufacturers thought feasible, but failed to effect—the individual power fluctuations of the machines of a group could be merged into a general average; and if not, the arrangement was instantly convertible into one of a separate motor for each machine. Until motors can be made to run in parallel at all loads, it would seem better, in the case of planing machines, to run not less than three from one motor.

The separate driving adopted in the present installation gives no trouble; but the conditions of a separately driven planing machine are most unfavourable to high motor efficiency. Several methods have beentried for cutting down the "peaks" of the diagrams. Heavy fly-wheels, with a periphery speed of nearly 5000ft. per minute, have been adopted on the armature shafts to modify the speed variations, and for the same reason all pulleys on the driving shafts for planing machines have been made of cast iron, and specially heavy in the rim.

In one instance roller bearings for the driving shaft were tried, and appeared to save as much power as could reasonably be expected in view of the small proportion the frictional resistance of these bearings probably forms of the total resistance to be overcome.

Preliminary experiments were made to find the power absorbed by the machine alone. We give the figures below, in Table A. They are instructive.

It is obviously impossible to reproduce here the diagrams which were given in the issue referred to, but we may take from them a few striking facts. Take the case of the twin-screw planing machine, referred to above. Records were taken when it was ploughing a 12-ton plate, cutting at 9½ft. per minute, and returning at 19ft. Two tools, each 1¼in. wide, were in use, but the feed was only $\frac{1}{24}$in. A 20 horse-power motor was used. The diagram shows that the cut had no appreciable resistance, the go-and-return stroke absorbing just about the same amount of power, which amounted to from 7 to 8 horse-power. At the moment of reverse for cut the power went up suddenly to 14½, and at the reverse at the other end it rose to 29 horse-power. The motor at this time was shunt wound with an external resistance of 3 ohms. in series with the armature. The influence of this was very marked, for when the resistance was cut out the ammeter recorded a maximum of 36 horse-power. To get over the peaks a fly-wheel, as already mentioned, was mounted on the armature shaft. A record from the same machine, with a 16½-ton plate cutting at 10, and returning at 20, with one tool in use, and a feed of $\frac{1}{12}$, the motor being slightly compounded, gave still a constant load for go and return, and, moreover, the high testimony to the value of the fly-wheel, but it is rather spoiled by the next diagram, which, under almost the same conditions, with the exception that two tools were used, and the feed was increased to $\frac{1}{7}$, shows a maximum horse-power of 30, and at the reversal to cut of 20½ horse-power.

TABLE A.

Double-screw planing machine, heavy pattern, 14ft. 8in. between standards; cutting speed, 10½; return, 14¾ft. per minute:—

	H.P. Momentary at start.	H.P. During stroke.
Table, about 25 tons, empty:—		
Cutting stroke	22½	7½
Return ,,	24	12
Ditto, with 8-ton plate:—		
Cutting stroke	24	12
Return ,,	25½	18
One tool cutting	24	12
Running shaft only	—	5
Running idle pulley on countershaft	—	1½

Similar machine, rack driven; cutting speed, 10ft.; retur 16ft. 8in. per minute; table loaded with plate of 20 tons, eight too surfacing; cut, $\frac{1}{16}$in. to $\frac{3}{8}$in.; feed, about $\frac{1}{5}$in. per traverse:—

	H.P. Momentary at start.	H.P. During stroke.
Cutting stroke, tools disengaged	16½	6 to 7½
,, ,, cutting	—	9 to 10½
Return ,,	18	9

Side planing or "ripping" machine; pair of saddles driven by screw, and holding 1in. ploughing tools, one cutting and one returning; speed, 9ft. 9in. per minute:—

	H.P.
Running idle pulley on machine	2
,, machine without tools	1½
Good substantial cut	3
Heavy cut	4½
Excessive cut, risking breakdown	5½

Large slotting machine; tool not balanced; cut, 1¼in. wide; feed, about $\frac{1}{8}$in.; very hard and tough material:—

	H.P. Momentary at start.	H.P. During stroke.
Cutting stroke idle, assisted by weight of tool arm	—	7½
Cutting stroke cutting, assisted by weight of tool arm	—	8
Return stroke, against weight of tool arm	15	10½

This is probably as large and heavy a machine as has ever been made for slotting. Some power might be saved by balancing the tool arm, but the cross slide being specially constructed to revolve through a whole circle, this would involve complication.

We may here insist upon a point that is sometimes overlooked or forgotten. In thinking of the power absorbed in overcoming the inertia of the machine at the moment of reversal, the weight of the table and its burden are frequently alone considered, the inertia of the

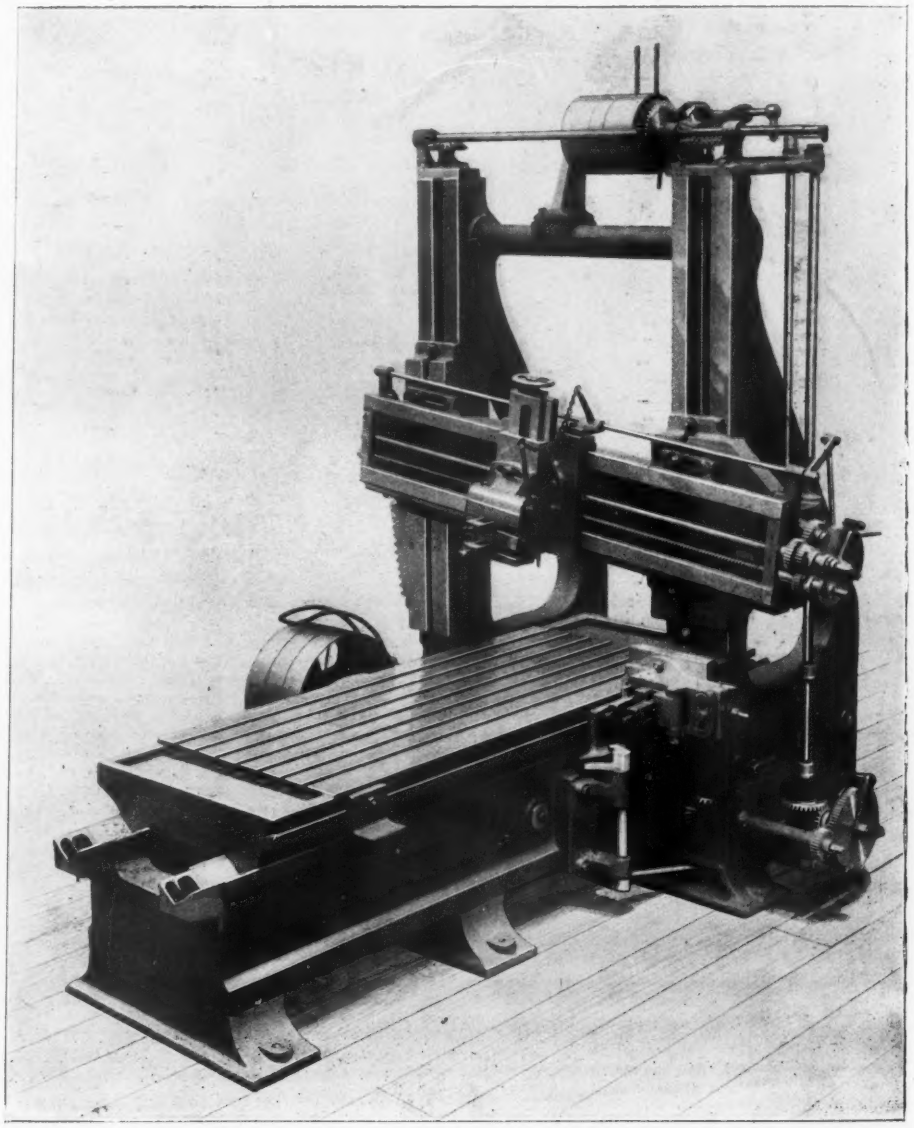


Fig. 3—HULSE'S PLANER, WITH SWIVELLING CROSS SLIDE

revolving parts being entirely neglected; but it would be easy to show that the momentum of fairly heavy wheels revolving at high velocities is by no means inconsiderable, even in proportion to the inertia of the heavy table and its load.

Many plans have been tried to get over the loss of power and the shock that results from suddenly stopping the table at high speed. Spring buffers at the table ends find favour with some, others have interposed springs in the driving-nut or screw of screw-driven machines; whilst in a machine which is illustrated in this Supplement a spring working on the same lines as a lightning tapper is being used, and is giving excellent results; and in yet another the momentum of a fly-wheel is employed at the instant of stoppage and reverse. With increasing cutting speeds the need for some method of preventing shock has grown, and will continue to grow, as the speeds get higher. With speeds up to 30ft., and even 35ft. per minute, well-designed rack gearing does not leave much to be desired. There is very little jar at the instant of reversal. There are several forms which such gearing may take. A simple rack may be used, and may be driven either by an ordinary pinion, which in such circumstances is made of exceptionally large diameter, so that many teeth are engaged at a time, or the Sellers drive may be employed. In place of the plain rack, a stepped rack, either double or triple, is adopted by many makers. For very heavy work the rack is replaced by screws. Of the Sellers drive it is desirable to say a few more words. It consists of a long worm of very steep pitch, driving a straight rack the axis of the worm being so inclined that the teeth engage properly with the rack. The action is similar to that of a worm, with one important difference—the end thrust on the pinion is greatly reduced owing to the inclination of the shaft. Several makers employ this form of drive with marked success. There is no shock at the instant of reversal, but neither is there any shock with well-made machines of other kinds. This is a point about which we have taken some trouble to satisfy ourselves, and there can be no doubt about the result. In the works of Dean, Smith and Grace, of Keighley, who have made a study of high-speed cutting, we saw a planer made by themselves, working at over 40ft. per minute and returning at 80; it had a plain rack; at Joshua Buckton's a Sellers drive planer, cutting at 25 and returning at 75, was shown to us in operation; at Bradley and Craven's we saw a machine by Darling and Sellers, with triple rack, working also at a good speed. The hand might be put upon the table of any one of these machines, and if the eyes were blindfolded the moment of reverse could only be told by the difference of direction of motion. We insist on this point, to show that in a well-made machine, no matter what the drive may be, shock is no longer a bugbear at the speed now commonly in use. Absorption of power at this instant is quite another question, and it is in this respect that improvement is to be sought. We have already explained how great the demand may be in an ordinary machine. On page xi. we give some particulars and diagrams representing the power absorbed in a recently invented machine. The whole point about the gearing of this machine is the utilisation of the energy stored in a rapidly rotating fly-wheel. The improvement in the result is very obvious. The use of a fly-wheel for such a purpose is, of course, no new thing. Punching and shearing machines depend upon the wheel to meet the momentary tremendous increase in load, and makers of planing machines have long recognised that the same principle may be applied to such machines. It is usual to make the wheels that always revolve in the same direction as heavy as possible, whilst those that have to reverse are made as light as requirements will allow.

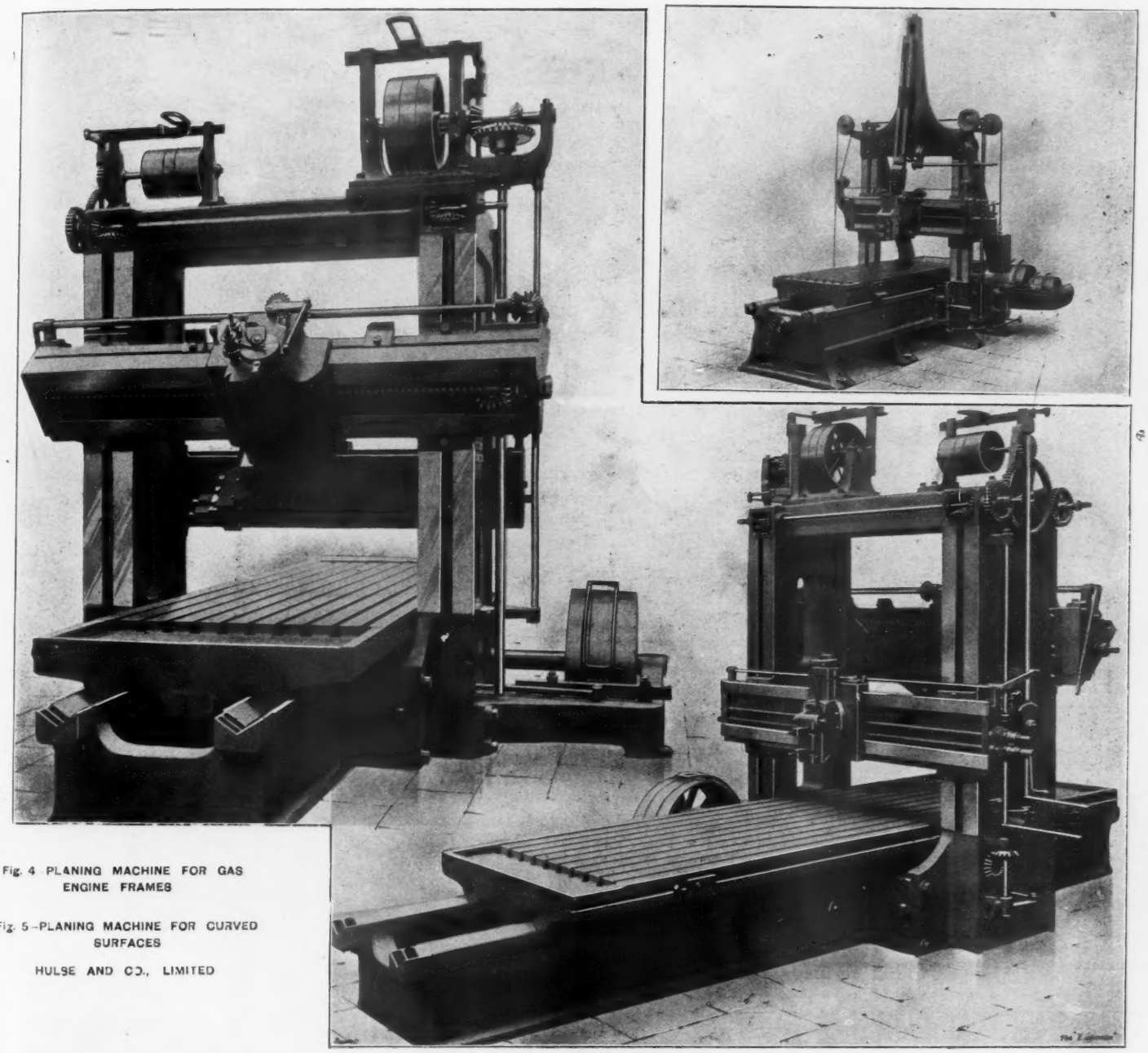


Fig. 4 PLANING MACHINE FOR GAS ENGINE FRAMES

Fig. 5—PLANING MACHINE FOR CURVED SURFACES

HULSE AND CO., LIMITED

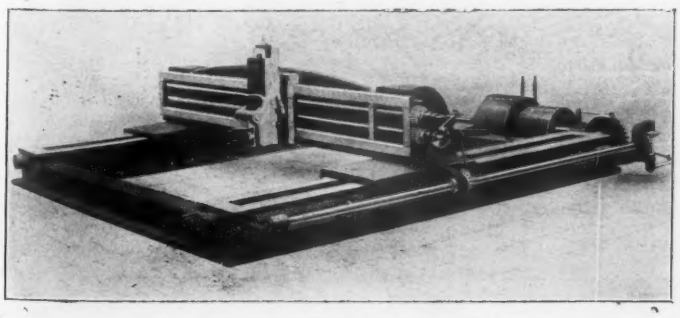


Fig 6—HULSE'S PORTABLE PLANER

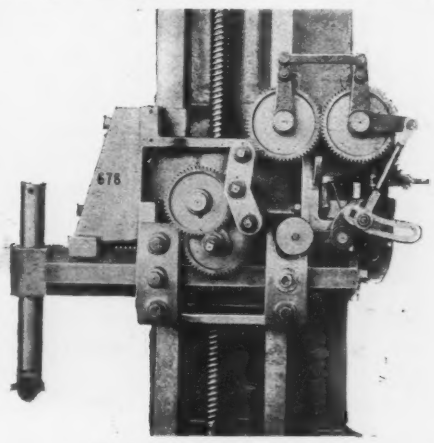


Fig. 7—DETAILS OF TOOL BAR

The former are made of cast iron, the latter frequently are built up of steel. Sometimes the countershaft is given extra momentum — Buckton's have such a device in their works; a fly-wheel is keyed on the countershaft, and by its inertia helps to meet the momentary load at the instant of reversal. This is a very excellent plan, which might be more widely used than it is. Many shaping and slotting machines are also fitted with heavy fly-wheels—in fact, it is the general practice with them—and they are of material assistance both in the cut and the reverse. In them, since there is no reversal of rotation of any parts, the value is very marked. Probably the neglect to develop this particular line of improvement in places is due to the fact that all the attention has been turned on the table and not sufficient given to the rotating parts, which, as we have shown, are responsible for the absorption of a very large proportion of the power.

Let us turn to other points: the feed and speed of planers. The question of feed has attracted a great deal of attention of recent years, and to give the American his due, we believe he has been responsible for the improvement in the method of effecting the "pick." With the old plan everyone is acquainted. Stops on the table struck against a lever which worked a ratchet wheel and imparted the feed. The reverse was actuated at the same time, and the amount of the feed depended to a certain extent on the distance the table ran before it was stopped. The feed was, therefore, not positive, and it was difficult to make it large without complications. Two plans have been adopted to get over these objections. One is to drive the feed by friction, allowing it to give a feed wheel half a revolution and no more. The action takes place suddenly at the end of the stroke, and is entirely independent of the travel of the table. From this wheel the feed is given in various ways that are readily conceivable, and will be found illustrated in these pages. Another plan, which has been developed by Buckton's, is to drive the feed by an independent belt and pulleys. At a given instant a friction clutch is thrown in by the machine, and throws itself out automatically at the end of one revolution. With this wheel a variable train of wheels is connected, from the final one of which the feed motion is taken. Such a gear obviously permits of unlimited feed. As much as 2in. is constantly employed. Both these plans are good. They are very quick in their action, and necessitate only a very small overrun of the table, just enough to clear the tool. They are not obtained without the sacrifice of some simplicity; but that is not the obstacle it used to be. Automatic machines have hardened us to elaborate mechanism, and so long as a gear works well and achieves a really desirable object, whether it is complex or not hardly enters into the question—except when price is a consideration.

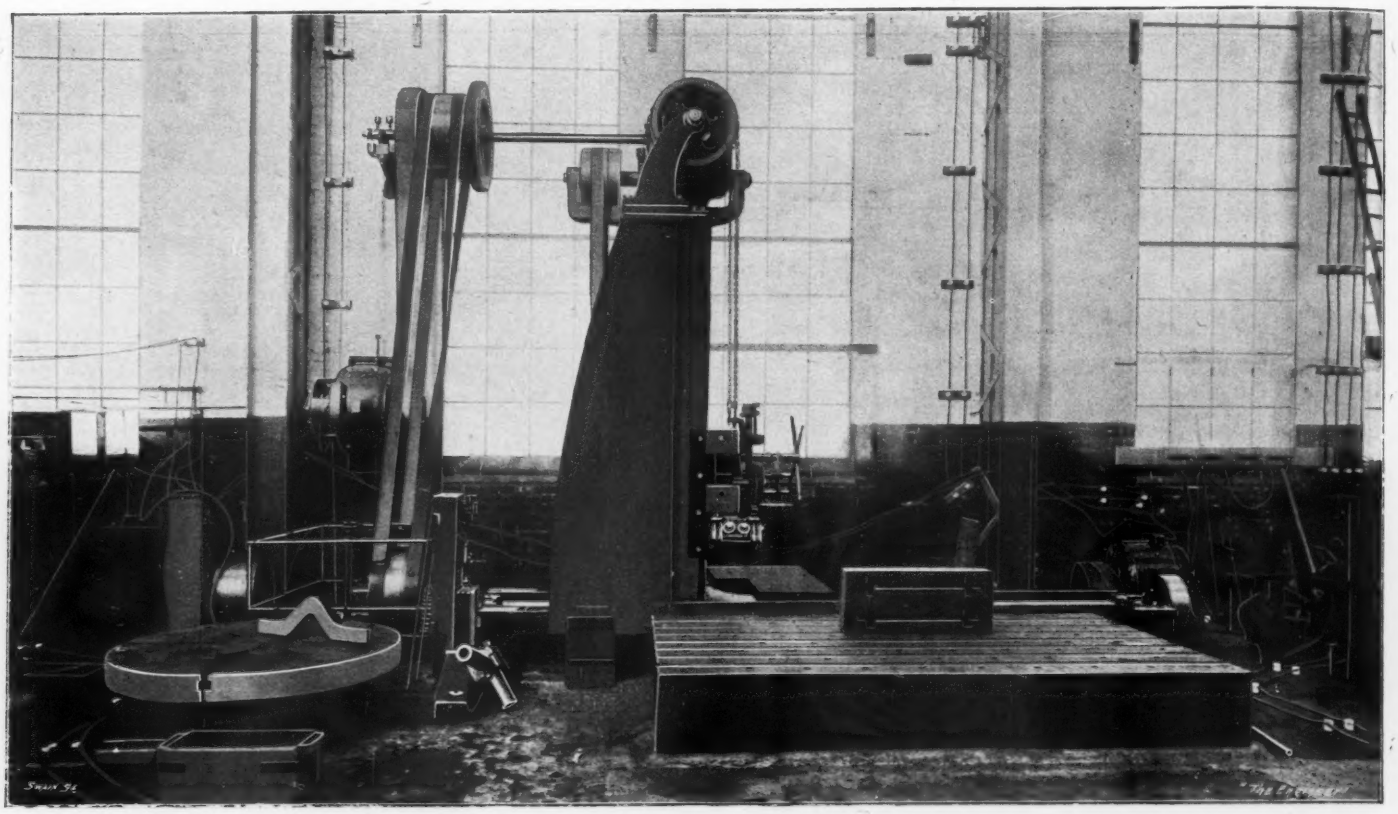


Fig. 8—BUCKTON'S VERTICAL PLANER

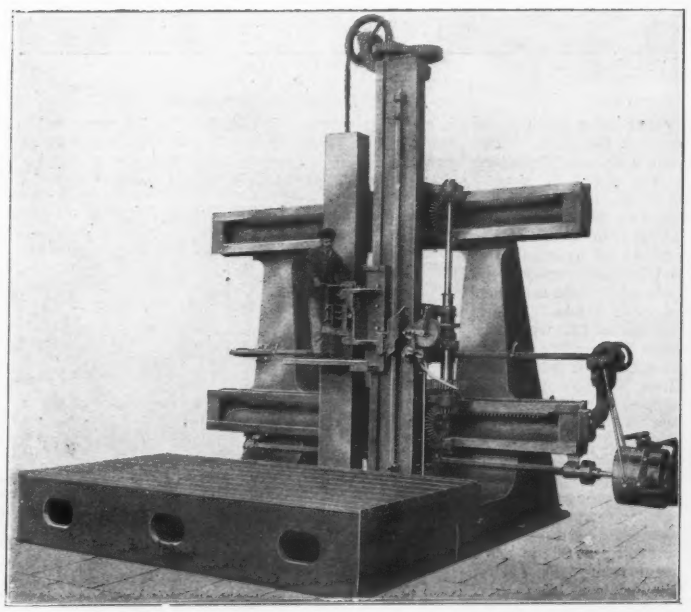


Fig. 9—BUCKTON'S VERTICAL PLANER

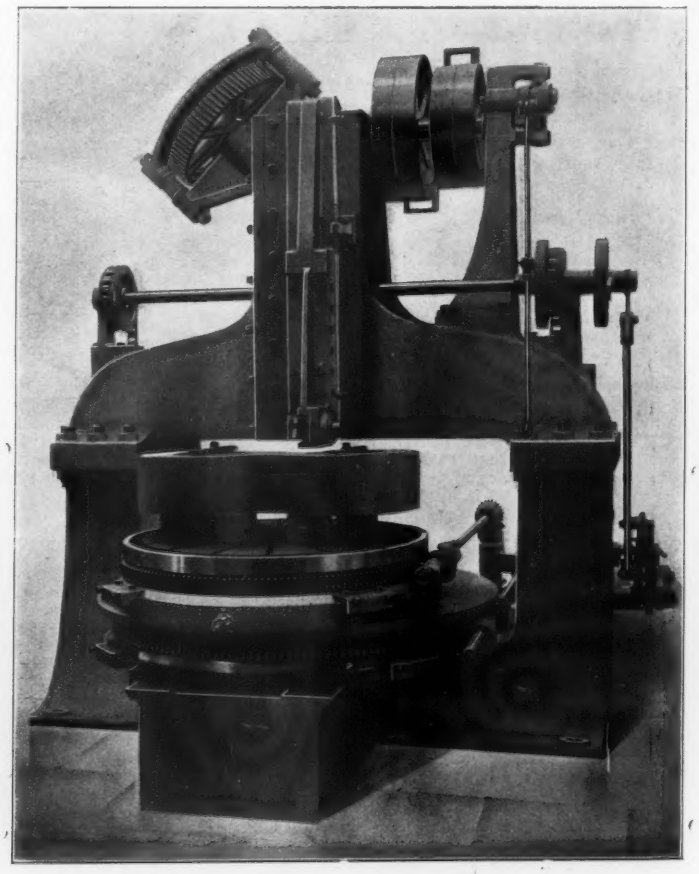
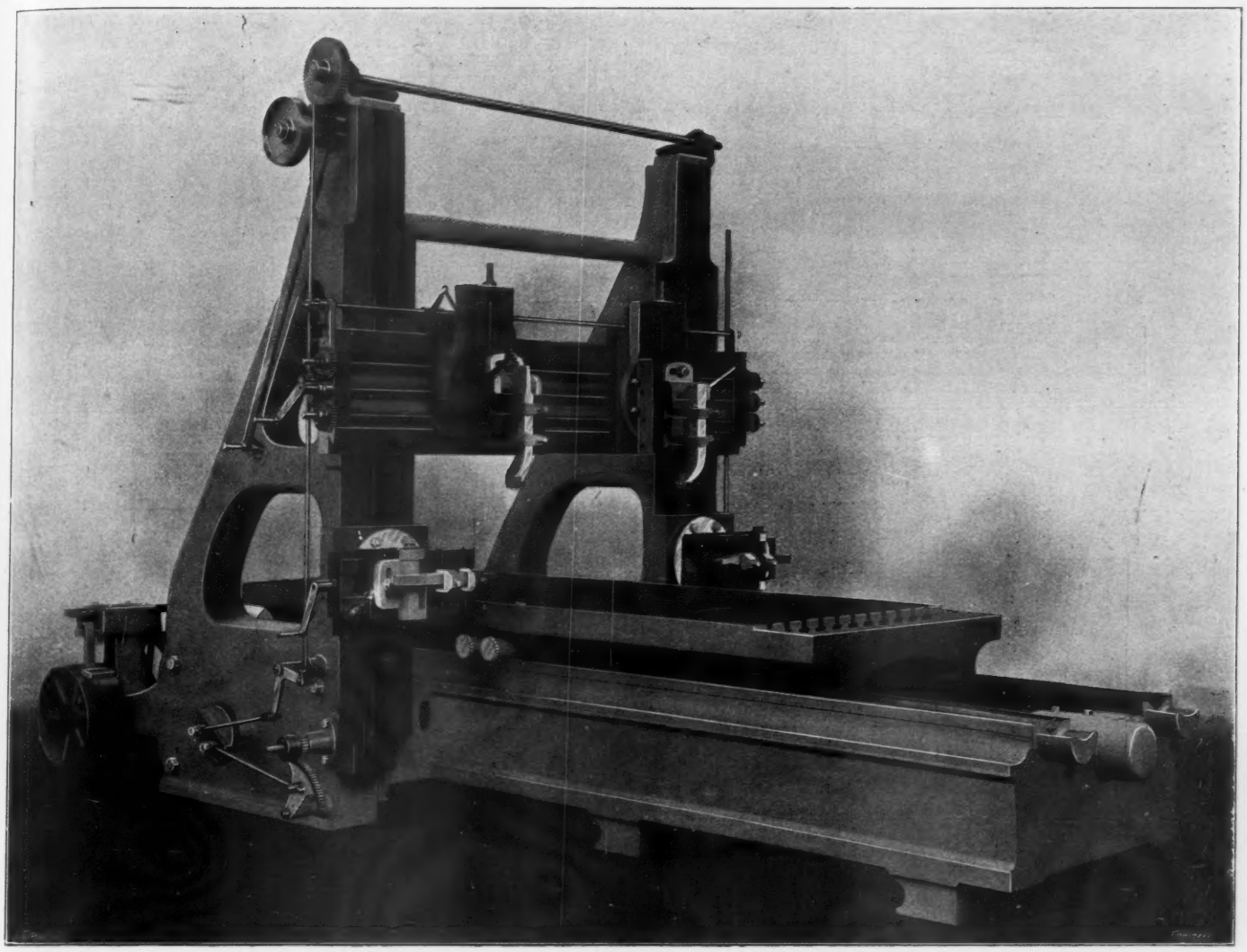


Fig. 10—BUCKTON'S CRANK WEB SLOTTER

On the question of fast cutting in planing machines a good deal might be said. At present the lathe and the drill are monopolising all attention, and only here and there is any experimenting with reciprocating machines being attempted. There is one very grave difficulty to be faced. Every machine hand knows that once a machine has got well into its cut it will do far more than it could attempt at starting. A very crude and striking example

PLANING MACHINE

BEYER, PEACOCK AND CO., LIMITED, MANCHESTER, ENGINEERS



of our meaning is afforded by the turning of uneven bodies or parts that are not complete circles, the ends of slotted cranks for instance. Every time the high part strikes the tool it seems to jar the machine through and through, and a very slow speed and a gentle cut have perforce to be employed. Now, the planer, the slotter, and the shaper are in precisely the same position. At every reverse for cut the tool has to enter solid metal, and at a high speed the tool runs a danger of being broken. In the planer the construction of the reversing motion is such that the acceleration for the first instant is not very great, and hence if the stroke is so arranged that the table has not got well under way before the tool engages with the work the shock is not very serious. Were it otherwise it is doubtful if planers could be used at anything like the speeds now attempted. Possibly some way of overcoming this difficulty will be devised. There is yet another interesting consideration. At present the maximum ratio of reverse is from three to three and a-half to one. That gives quite as high a rate of travel, say 130ft. per minute, as is desirable, and it will not be greatly increased in any except the smaller machines. But if we start to cut at 60ft. the ratio is at once reduced, and as the cutting speed gets higher, the advantage of high speed reverse becomes less and less; it is, we mean, impossible to retain the ratio that is possible with slower cutting machines. We are thus brought face to face with the question whether it is not better to run the machine at a constant speed and cut on both strokes? We are inclined to think that the objection to double cutting is being worn down, and in view of the desire to use high speed steels and to get increased production from our machines, we should not feel surprised if in a few years time double cutting is the accepted method of roughing down, the finishing cut being made with a single tool, or in cases that will permit of that arrangement, one tool in each of two tool-boxes, one cutting in each direction, and thus equalising the load.

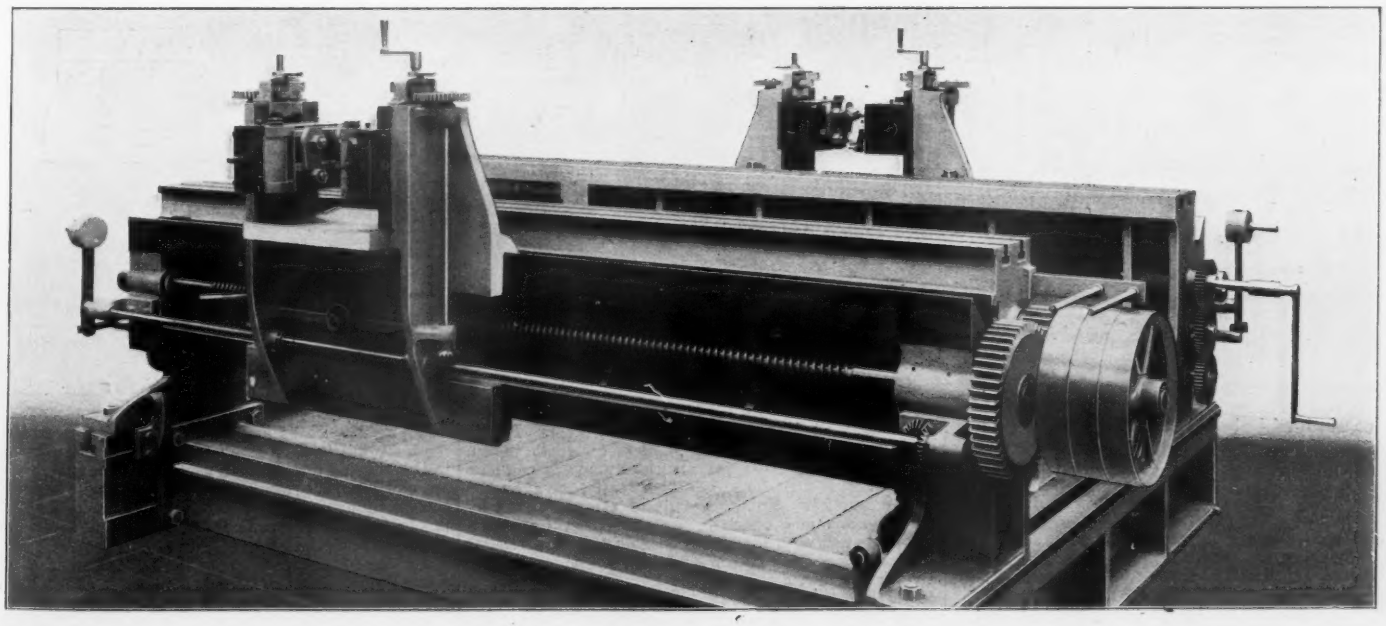
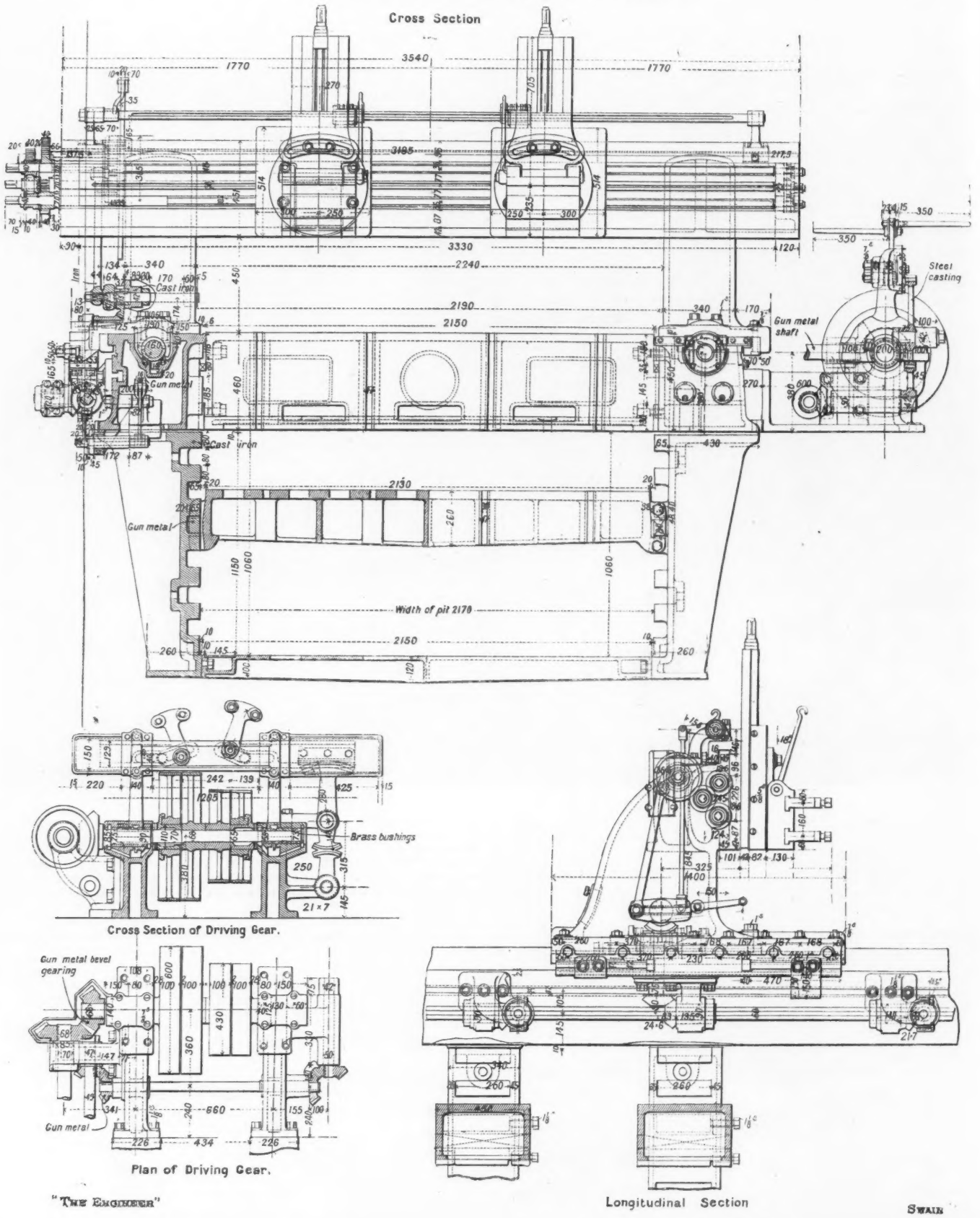


Fig. 11—BEYER, PEACOCK'S PLATE EDGE PLANER

There are several other points about the planing

PIT PLANING MACHINE

SACHSISCHEN MASCHINEN FABRIK, CHEMNITZ, ENGINEERS



"THE ENGINEER" SWAIN

machine which might be discussed with profit, and the shaper and slotter, too, present some interesting problems, but we have already devoted more than enough space to generalities, and we shall now turn to the description of a few typical machines of British and foreign origin.

We give on pages i., ii., and iii., a number of illustrations of planing machines made by Hulse and Co., Limited, of Manchester—a firm which turns out an exceptionally large amount of special work. It will be observed that not one of the machines we illustrate but differs in some particular from the ordinary standard type of planers. It is for this reason that we have selected them, because it would be difficult to find a group that would show more clearly the great range of variations that is possible in this class of machine. At the same time, we ought to make it clear that a standard type of planer is made by Hulse's. Much of the work done by this firm is, as many of our readers are aware, primarily intended for the machining of war material. The powerfu planer illustrated on page i. is a case in point. It was designed originally for operating upon casemate plates. It is a combination machine, for it can plane, it can slot, or it can cross-cut. The gearing is well shown by the engraving. For planing, a pair of screws, driven by bevel wheels and pinions, are employed; for cross-planing, a pair of horizontal screws, driven by a vertical shaft, and bevel pairs come into play; whilst for slotting, a vertical screw, driven by the same vertical shaft, is employed. This vertical shaft is driven by a horizontal shaft, interrupted at a convenient point, and fitted with a positive clutch, so that it may be wholly uncoupled when desired.

When the machine is used for ordinary plate planing the feed is effected by the worm gearing seen on the horizontal shaft. When slotting the feed is obtained through the ratchets on the end of the cross slide, which are actuated by a rocking shaft. During this operation the table may be tightened up by the side strips, but in practice it has been found that the two screws hold it quite rigid. There is only one reversing gear for all motions, but it acts in different ways. For planing it works much in the usual way, with a tumbler; when cross planing, the reverse is effected through the rocking shaft seen between the two beds of the cross slide, and finally, when slotting, it is brought about in the usual way by a vertical shaft.

Another special machine by the same firm which will particularly interest gas engine builders is shown by two views on page iii. It was got out for planing gas engine frames and similar work. It will be observed that it has two wholly independent cross-slides—one of the normal type, the other with its face inclined at 45 deg. The first is, of course, for ordinary flat planing; but the other cuts across, the table being locked, and is intended for machining the inclined bearing in the frames. The saddle upon it is driven by a screw of very quick pitch, and is provided with a special form of tool-box. For ordinary planing, the table is propelled in the usual way, by rack and pinion; for cross-planing, the belt pulleys on the

cross-stay at the top of the machine are used, transmitting motion through bevel gearing to the quick-pitch screw. The striking gear for reversing the motion is clearly shown in the two views. Dogs, fixed upon the slide, as seen in the back view, actuate both the feed and

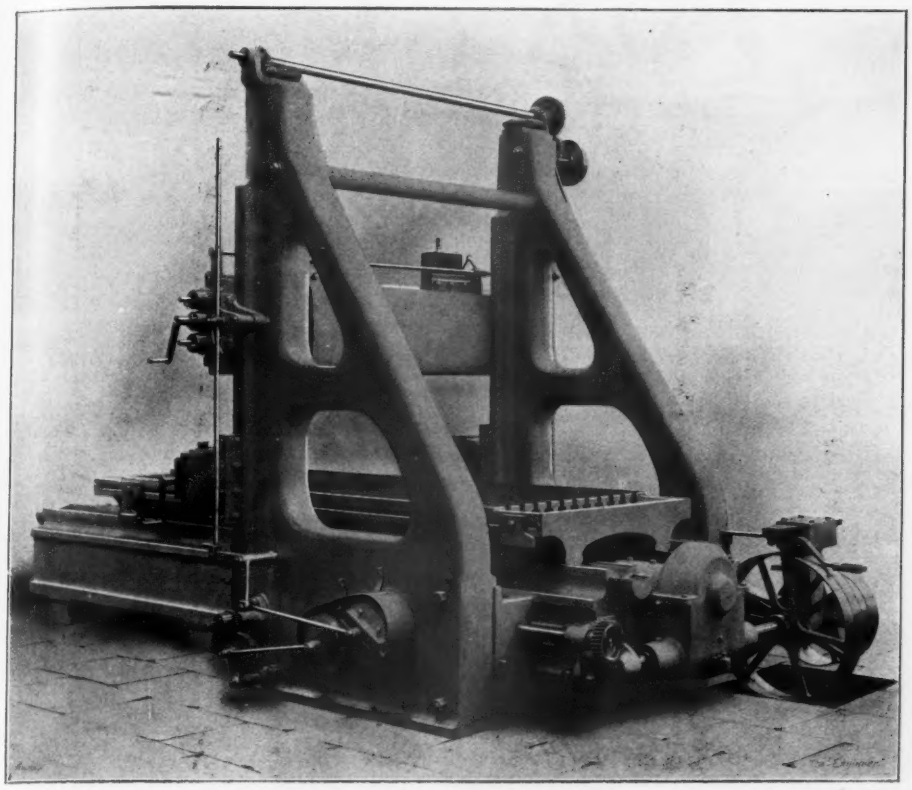


Fig. 12—BEYER, PEACOCK'S PLANER, BACK

the reverse—the former directly, the latter through the horizontal and vertical shaft and the bevel gear uniting them. Power gearing for raising both slides is fitted; they may be raised or lowered, together or separately, by slipping the correct wheel into gear.

A planing machine that, besides doing ordinary flat work, will also get up concave faces, such as the bases of steam domes and boiler seatings generally, is shown by Fig. 5. How it acts will be obvious at once. The work is mounted in the usual way on the table, which is traversed back and forth by a strong screw and two-speed gearing. Instead, however, of the tool-box being mounted direct on the cross-slide, it is carried on a saddle in such a way that it is capable of receiving independent vertical motion. To its summit is attached the strong radius bar which is a prominent feature in the engraving. The fulcrum is an adjustable block, so that the active length of the radius bar may be varied. Evidently, as the saddle is fed across the cross slide, the box is raised and lowered by the radius bar, and thus the correct curvature is given. To facilitate adjustment, the tool-box and radius bar are counterbalanced. A further point must be noticed; it shows well how carefully these things are thought out. Probably, for large radii, at any rate, the tool might be ground to such a shape that it would cut the outer parts of the curve as readily as the central part, to which it would, of course, be normal; but, to be most efficient, the tool should be always radial, and consequently the makers have made the tool-box to swivel, and have fitted a sort of feed motion which keeps he tool always in the right position.

Another machine which has one feature out of the common is shown in Fig 3. How it differs from the ordinary machine is very obvious. The cross slide is, as will be seen from the photograph, arranged in such a manner that one end can, when required, be raised higher or dropped lower than the other end, so as to plane work inclined transversely to the surface of the table of the machine. It is pivoted at one end to one of the back plates, and the other back plate is provided with a rack in the form of a segment which engages with a worm carried by the cross slide, and provided with suitable means of actuating it not affected by the raising or lowering of the back plates for adjusting the vertical position of the cross slide. In order that the swivelling of the cross slide may not interfere with the self-acting motion of the tool-box or the self-acting relieving mechanism of the tool on the return stroke of the table, the feed and relieving mechanism is actuated through suitable gearing carried by the cross slide mounted upon the pivot about which the cross slide swivels. When the cross slide has been turned about to the desired position, it is clamped to the back plates by bolts in vertical grooves formed in the back plates and extending through transverse slots.

An interesting machine is that illustrated by Fig. 6. It is a portable planer, designed specially for machining the anvil blocks of steam hammers and other similar work in position. It is a kind of machine known generally as a pit planer, a type that is used with work too big to put on a planer table. The cross slide moves along two beds well braced together at the ends, being driven by two screws working in long gun-metal nuts. The tool-box can be fed vertically, horizontally, or obliquely. The machine in this case is driven by belts, but obviously it lends itself well to electric driving.

We might, had we space, describe many more planers made by this firm; but enough has been said to show what a great variety of work they undertake. Of the general design of their machines it is unnecessary to speak. In a sense Hulse and Co. is a conservative firm—they carry on the traditions of the best of our early toolmakers; in another sense they are progressive, in that they are always meeting new conditions. We make this remark with a moral in view. Nearly all the machines we have illustrated have vee beds, but—and this is the point—one of them has a flat bed. Now, if Hulse and Co. depart from a practice which they have in their long experience found satisfactory, there must be a great deal to recommend it, and our case in favour of the flat bed is considerably strengthened. We hope they will not deprive us of this satisfaction by telling us that they only use it in the largest machines; but even then the argument would have more weight than if a less well-known firm used it in all their planers.

In most planing machines it is the work and not the tool that travels, but it occasionally happens from one cause or another that a departure has to be made from the customary plan, the work being held fast while the tool travels over it. The vertical planers already described are of this kind, as are also the side planers. But there is yet another machine which bears more resemblance to an ordinary planing machine, the only difference being that the table is fixed, whilst the cross bar carrying the saddle moves backwards and forwards over it. An illustration of a machine of this kind has already been given—Fig. 6—and now on page vi. we give drawings of a planer of this kind made by the Sächsischen Maschinen Fabrik of Chemnitz. This machine is further illustrated by a small engraving, Fig. 14. It is in use in the works of the makers, and is employed either to machine the edges of plates or to get up the surface of big work that is dropped into the pit. The driving mechanism is shown clearly by the drawings. The cross bar is traversed along the bed by two screws, one under each saddle, and the reverse is effected in the ordinary manner. The table in the pit can be raised or lowered to suit the work in hand, the final adjustment being made on the saddles and tool boxes.

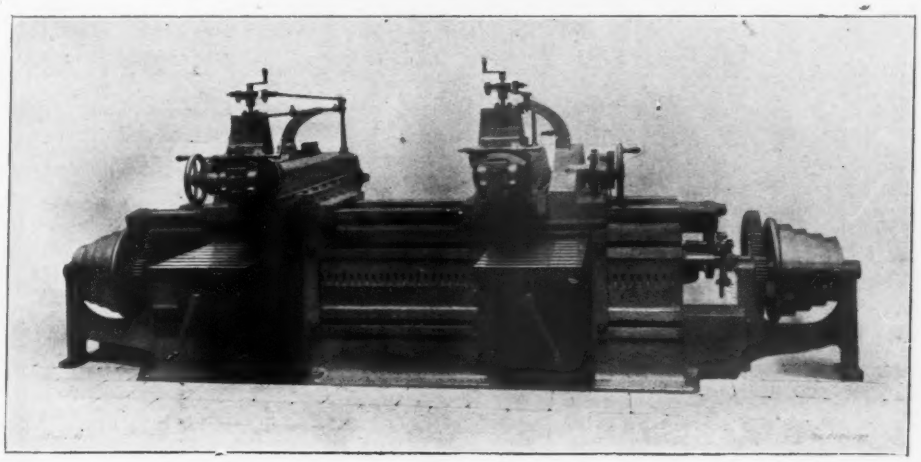


Fig. 13—ARCHDALE'S SHAPING MACHINE

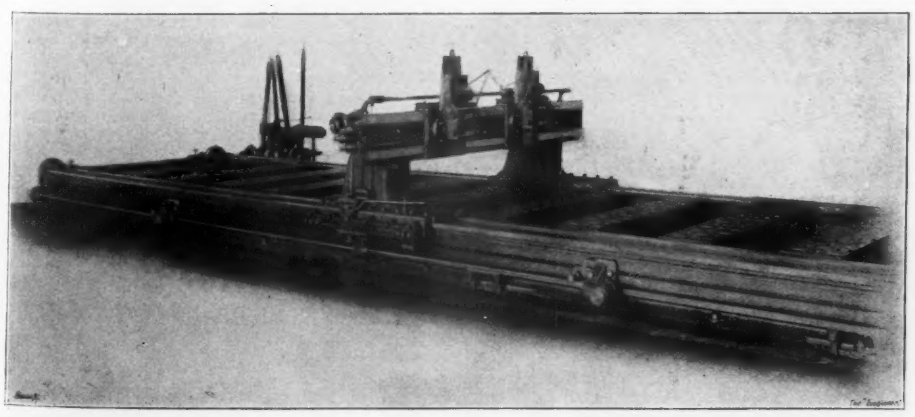


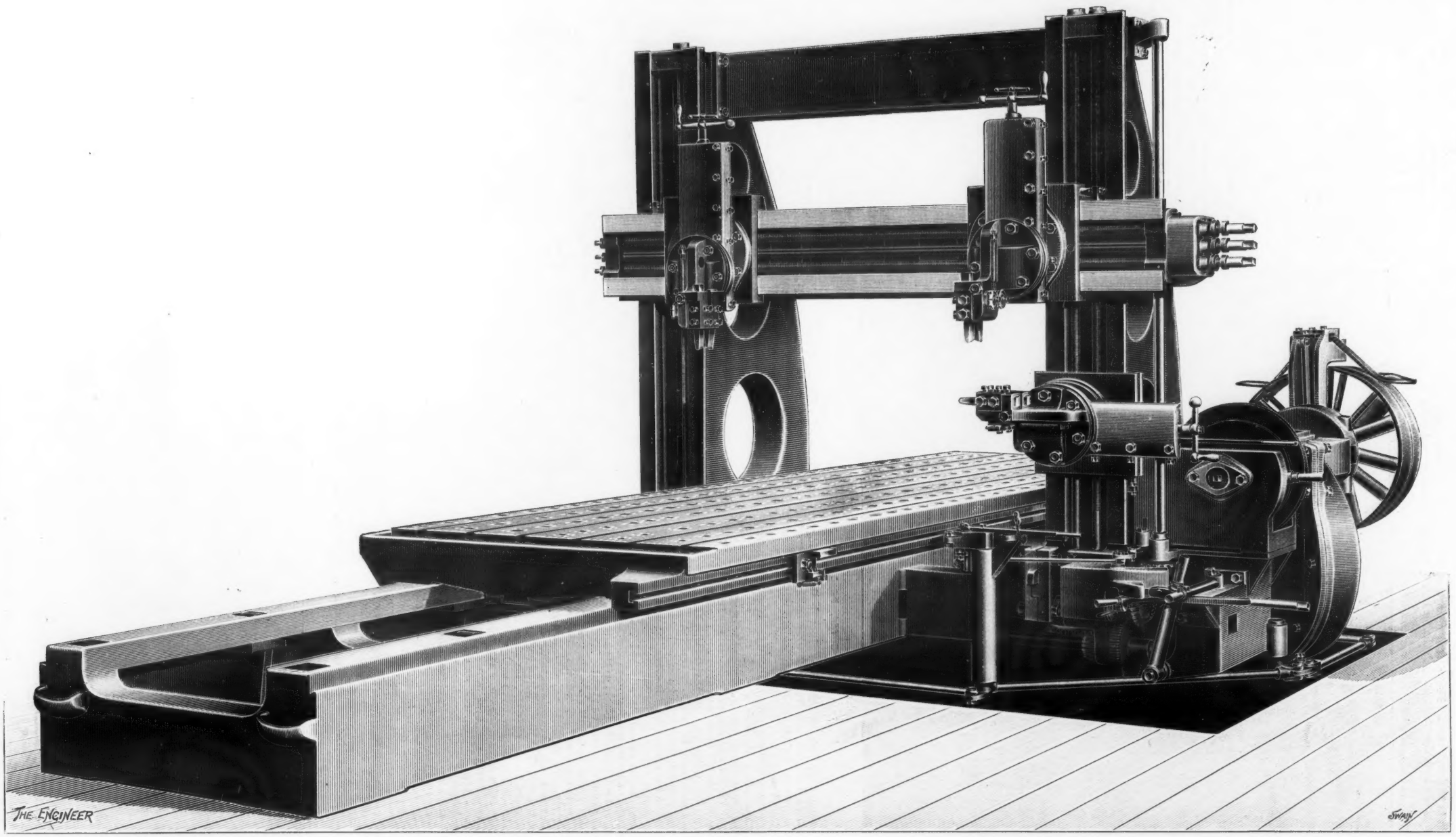
Fig. 14—PIT PLANING MACHINE

It is perhaps a little remarkable that machines of this kind do not enjoy a greater popularity, for obviously they take up much less shop room than ordinary planers, which in some localities is a matter of much importance. The construction of a suitable pit is not a serious matter, and more difficult jobs are faced in machine tool work than the construction of a table that will fall or rise quite horizontally. It may be said that the machine has not the stiffness and solidity of the ordinary planer, but this is open to some doubt, since what is lost in one way is gained in another. The heavy table moving in well-bedded slides is an excellent mechanical arrangement, but in order to accommodate high work lofty standards are necessary, and have to be made of great strength and stiffness. In the pit planer only dwarf standards are required, and the table is rigidly fixed, so that there seems to be almost a balance in its favour. Against it the duplication of driving gear may be urged, but several of the ordinary planers illustrated in this Supplement have duplex drive, so that this argument has not very great weight. A great point in favour of the pit machine is that the weight so moved is constant, whilst in the planer it varies with every job mounted on the table.

If we look at these *pros* and *cons* it will be seen that there is a great deal to be said in favour of the pit planer, and it is possible that we might do well to desert our conservative notions and attempt to develop this class of machine. What is wanted is a good statement of the objections to it from engineers who have used it, and particularly some competitive tests. It is already largely

DOUBLE-CUTTING PLANING MACHINE

JOSHUA BUCKTON AND CO., LIMITED, LEEDS, ENGINEERS



used in armour-plate works, and several fine examples may be seen in the shops of Sir W. G. Armstrong Whitworth and Co., at Manchester They were, of course, made by the company.

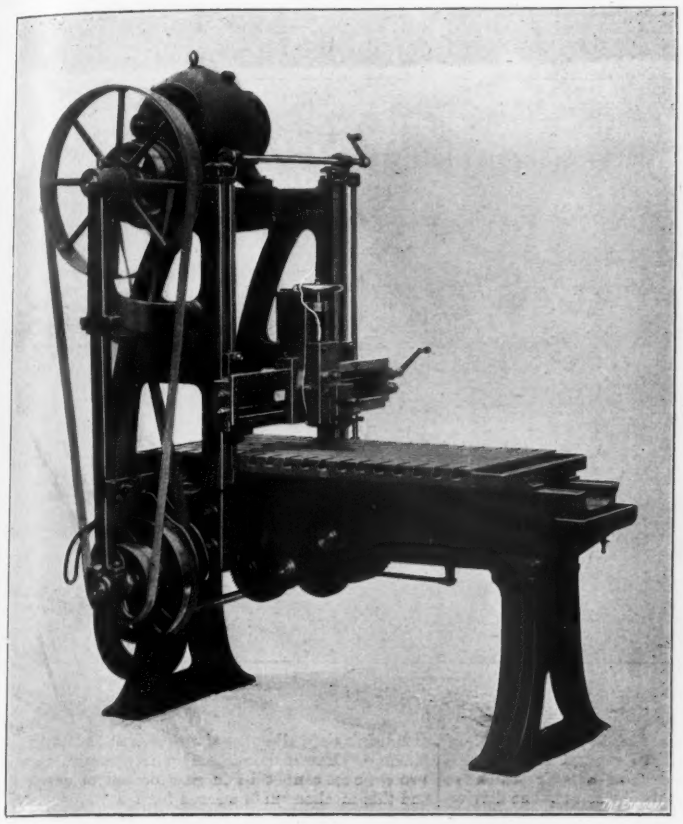


Fig. 15—ARCHDALE'S ELECTRICALLY DRIVEN PLANER

A firm which enjoys a good reputation for machines of the type we are discussing, of moderate dimension, is

Fig. 16—SLOTTING MACHINE

James Archdale and Co., of Birmingham, and the illustrations of a few of its machines which we are able to give will be studied with interest. It will not be necessary to say much about them, as for the most part they present but little out of the way in their mechanism, the neatness and elegance of the designs being the chief points to observe. Notice, for example, the design of the bed of the little shaping machine shown in Fig. 21, the tidiness of the gearing in the little planing machine that Fig. 17 illustrates, and the general design of the slotter shown in Fig. 16. In the latter the curious form of the driving link and the application of the balance weight may be noted. The table of this machine has, of course, all the usual motions. The ram is well carried in long slides, and has the ordinary adjustments. The reduction is direct, only one pinion and large spur wheel being used. To facilitate the adjustment for length of stroke, the link is indexed.

In the shaping machine to which reference has already been made, the ram is driven by a slotted link contained inside the bed and completely enclosed, access to it being possible only through a door in the pedestal. It is thus kept out of the way of dust and chips. The table can be adjusted vertically by hand, and has an automatic cross-feeding motion, whilst a vertical or oblique automatic down feed of the tool-box is also provided.

The little planing machine illustrated by Fig. 17 has a very quick return motion, the ratio being 4 to 1. It planes up to 5ft. long by 2ft. 6in. wide. The train of wheels can be seen under the table, and the large diameter of the wheel that gears with the rack will be observed. The reversing motion is effected by a circular cam just under the driving wheels. The two belt strikers are quite independent, and one has a slight lead of the other. The driving pulleys are sufficiently out of the way to permit of the machine being handled from either side. The bed in the machine illustrated has vee slides, but flat slides with dove-tailed slips are sometimes used instead. The self-acting feed is of the ordinary simple kind.

A very similar machine, but with a self-contained electric driver, is shown by Fig. 15.

We illustrate, Fig. 13, one more machine by this firm, a double-headed shaper, with absolutely independent drives and feeds. This is a comparatively large machine, the rams having a stroke of 24in., and the bed being some 10ft. long. The range of speeds provided for is considerable, four-step cones being mounted on the machine, and driven by two independent two-speed countershafts. The rams are driven in the same way as the ram of the small machine—Fig. 21. The connecting-rod being inside the rams a quite central thrust is given. All these machines have, of course, machine-cut wheels.

An attempt to get over the difficulty of the power wasted in the reverse has been made by Smith and Coventry, of Manchester, and the device has, we are informed, met with a good measure of success. A planer fitted with this gear is illustrated by Fig. 2, and some sketches taken from the patent specification show the construction very clearly. The device consists in providing on a shaft, which transmits the power for giving motion to the table, a powerful spring, which is compressed when the shaft starts to turn in either direction, thus absorbing some of the energy given to the shaft. When the mechanism is thrown over to reverse the shaft, a great part of the energy stored in the spring is given back to the machine. The principle employed to effect this end is that of the lightning tapper. On the driving-shaft—*a*, Fig. 19—is mounted a powerful coiled

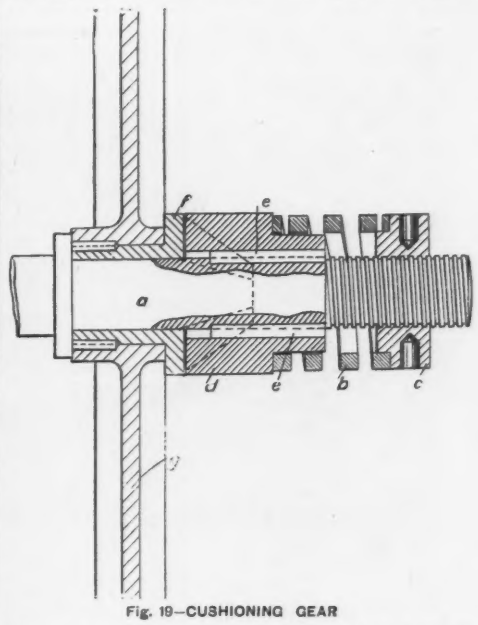


Fig. 19—CUSHIONING GEAR

spring *b* butting against a nut *c*, at one end, and at the other against *e*, one-half of a clutch attached to the shaft by a feather, but capable of endwise movement. The other portion of the clutch is mounted fast on a spur wheel *g*, which is free to revolve on the shaft. The coupling thus forms the only union between this wheel and the shaft. The clutch engages

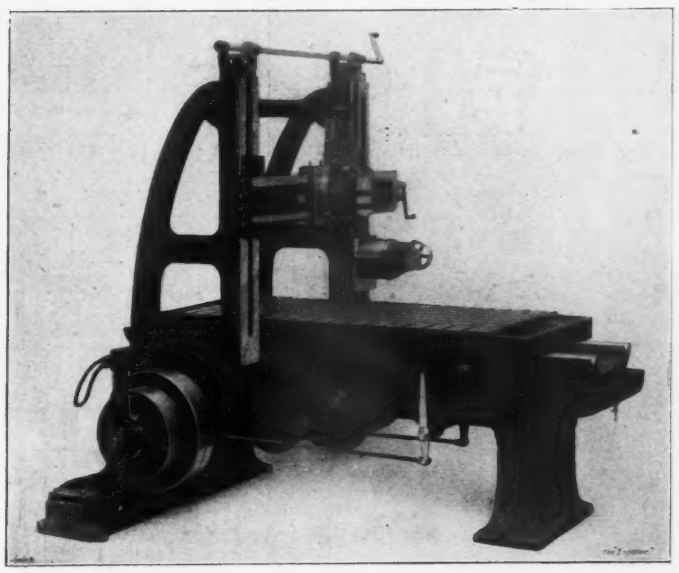


Fig. 17—ARCHDALE'S BELT DRIVEN PLANER

in the ordinary way, but the faces of the teeth instead of being straight are steeply inclined, as seen in the dotted

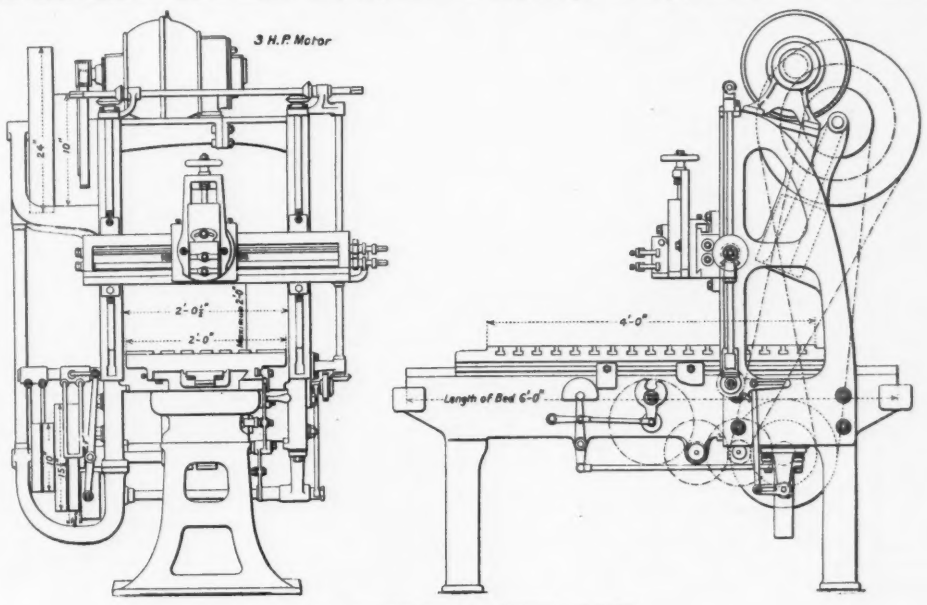


Fig 18—ELECTRICALLY DRIVEN PLANER

lines, so that if the shaft were held whilst the spur wheel rotated, the two parts of the clutch would be forced apart, compressing the spring b; the amount of compression depending upon the degree of resistance offered to the revolution of the shaft. When the coil spring is thus compressed by an amount proportional to the power being transmitted and the speed of rotation, the shaft rotates as if the spur wheel were keyed on it, except that there is a certain amount of flexibility, useful, it is claimed, in preventing injurious shocks whilst the machine is planing. In the actual machine the shaft a, of course, drives the table.

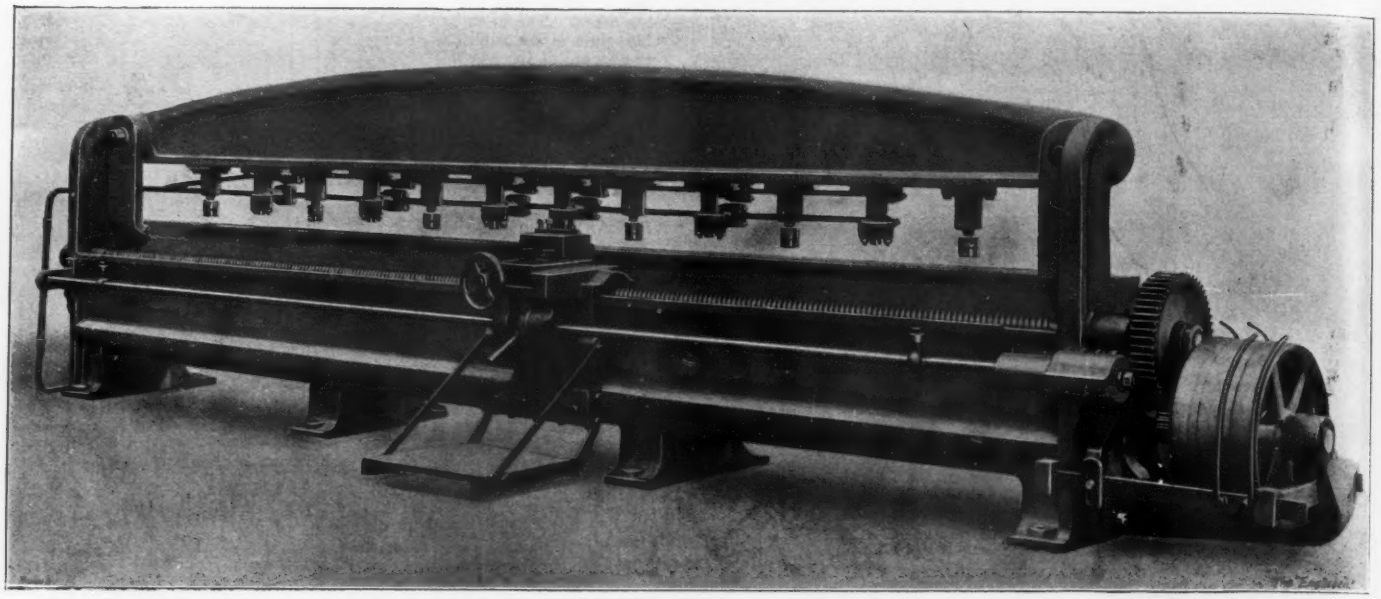


Fig 20—BUCKTON'S PLATE EDGE PLANER

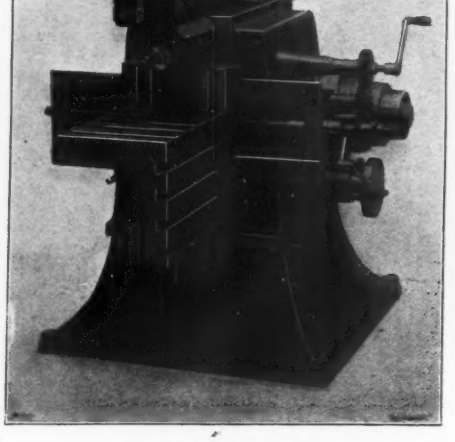


Fig. 21—SMALL SLOTTER

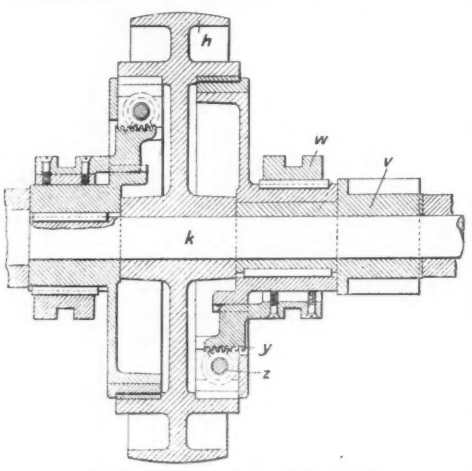


Fig. 22—PLANER REVERSING DRIVE

At each end of the stroke the driving gear is reversed in the usual way, but as soon as the driving force is removed from the spur wheel the spring acts through the medium of the clutch to drive it in the opposite direction, the next instant being again compressed as the table moves backwards. Thus it will be seen that the spring acts as a cushion as well as helping at the instant of reverse, the time when the greatest load comes on the machine.

We have already referred to the great loss of power in planing and similar machines due to the reversal of wheels rotating at high speed. To get over this, Messrs. Smith and Coventry have devised a gear which is illustrated in Fig. 22. With this device only one driving pulley is employed, and it rotates always in the same direction. This driving pulley is h. On each side of it is formed a clutch of the ordinary split ring kind, the racks y, actuated by the sleeve w, serving to connect or disengage these clutches. Free on the shaft, but coupled to the male part of the right-hand clutch, is the pinion v. External mechanism is arranged so that the two clutches cannot be in gear or out of gear together, and this mechanism is worked from a tumbler struck by

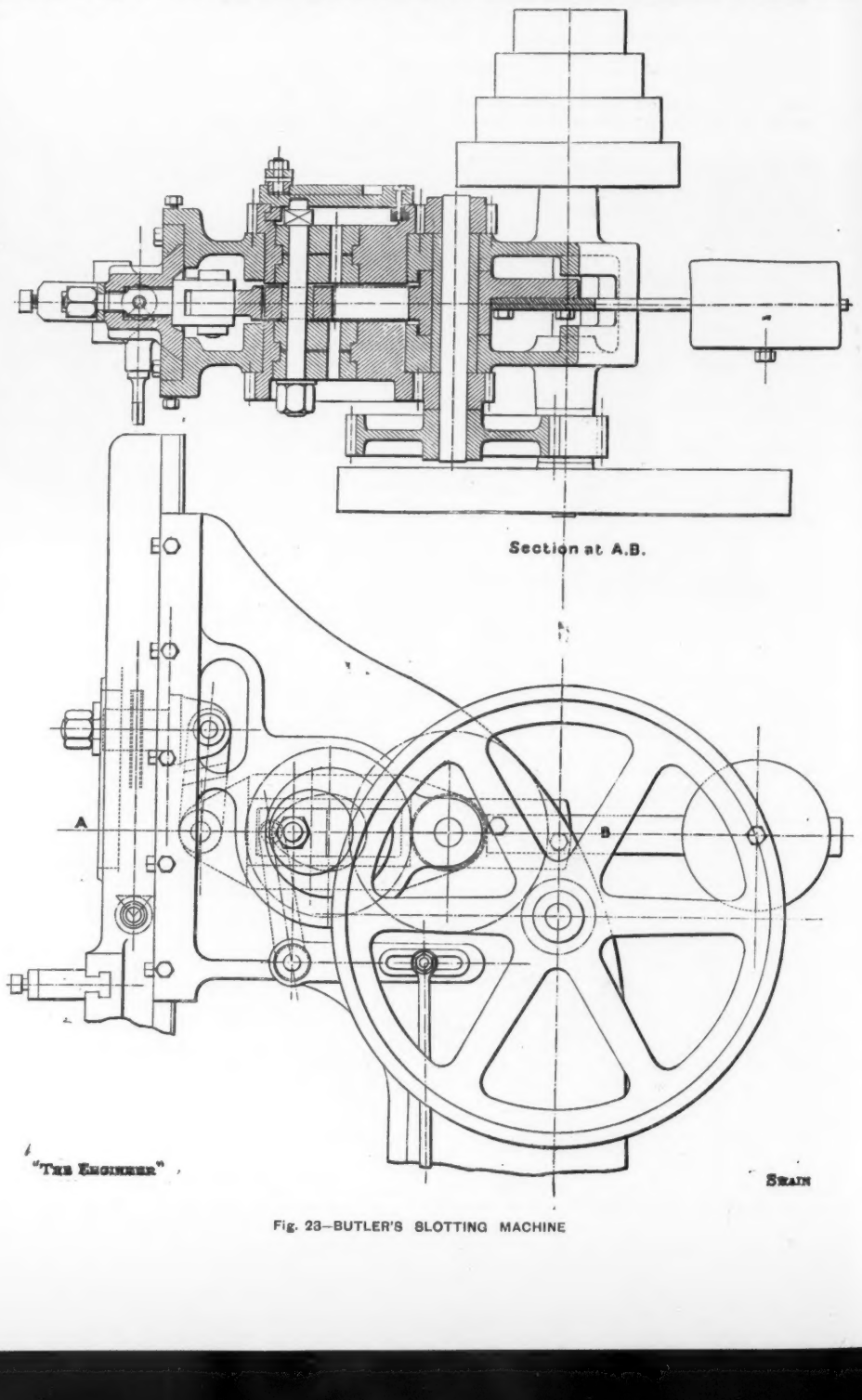


Fig. 23—BUTLER'S SLOTTING MACHINE

the table in its motion. Coiled springs are introduced in the gear to bring the clutch together quietly. By this device either the shaft *k* itself is driven or else the pinion *v*, one of them driving the table for the cut, and the other for the reverse.

There are a few firms of Yorkshire machine tool builders who have more than lived down the unenviable reputation which attaches to those of their trade in that county. It would be invidious to name all the makers who have gained this position; but all will admit that Joshua Buckton and Co. deserve a place amongst the first in the list. They have a peculiar experience, for they combine two manufactures which are rarely combined—the construction of testing machines and the building of machine tools. Possibly the knowledge wh ch they have gained with the

Fig. 24—BUTLER'S SLOTTING MACHINE

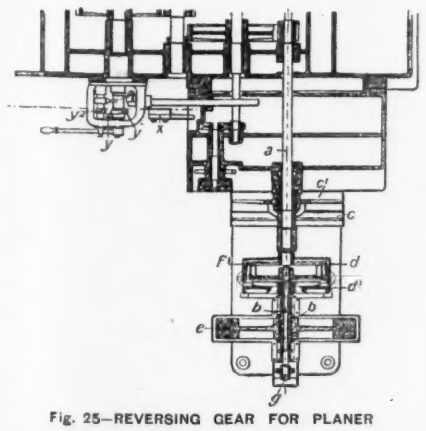


Fig. 25—REVERSING GEAR FOR PLANER

former has been reflected in the latter, for it is certain that they very well understand the need of massiveness and solidity in machines, and they are responsible for some of the most powerful machines in use in this country and abroad. A notable example is the crank web slotter illustrated on page iv., Fig. 10—a machine which takes an extraordinarily heavy cut. A few words about it that Mr. Hartley Wicksteed has written to us are worth quoting verbatim.

"There is no doubt," he says, "that straight line cutting produces the truest possible surfaces, and also that it can be applied with unlimited force, and with total absence of vibration. Punching and shearing machines are an extreme instance of this, where thousands of tons of pressure can be applied without vibration to remove any desired amount of material in the form of a punching or a sheared strip. The obvious reason of this freedom from vibration is that the work is upheld between the operating part of the machine and its anvil; the work therefore cannot spring away from the action of the cutter." This idea has been followed in the design of this slotting machine. It is a double standard machine for slotting the webs of built up marine crank shafts. These webs are roughly forged in outline, and there is often 3in. to remove in certain places round the profile. The machine illustrated will take a cut 3in. deep, and remove at each stroke a shaving 3in. wide. It cleans up

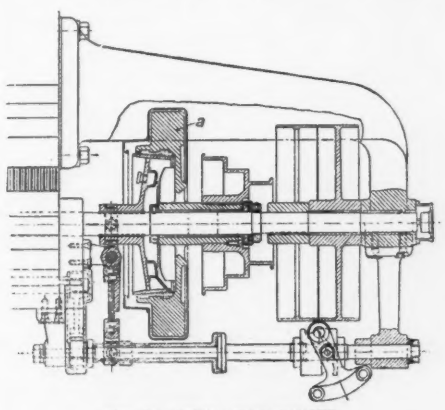


Fig 26—DRIVE FOR SHAPER

the work with a light cut on the up stroke, and finishes the profile to the correct curves and perfectly true, at one going round, with a bright finish ready to put into the ship. There are no chatter marks on the work, there is no vibration on the machine, there is no spring on the work itself, because it is compressed between the operating tool and the table of the machine, so that it cannot flinch from the cut. The ram of this machine is driven by a Sellers' spiral pinion.

We have mentioned that the return stroke in this machine takes off a light finishing cut; this cut, which is not more than ¼in. deep, cleans up the bottom corner that has been broken away by the heavy down cut, and is itself so light that it does not break away the top corner. In straight-line cutting machines, where the return stroke can be used, work is done with the utmost economy. The only want of economy in straight-line machines is

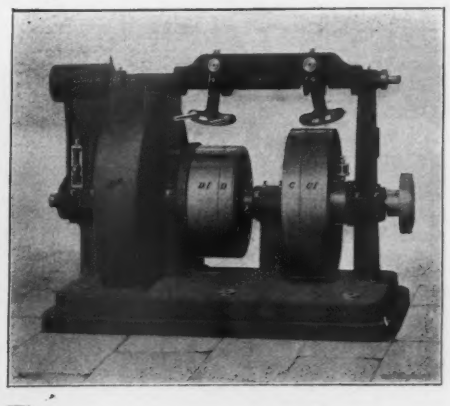


Fig. 27—REVERSING GEAR

where they have an idle return stroke. This double cutting is, of course, a strong point with Messrs. J. Buckton and Co., who have given a great deal of attention to the utilisation of the return stroke. They can, and do, make planing machines with 4 to 1 return speed of travel, but with heavy machines, and where plane surfaces form, at any rate, half of the work to be done, they recommend and practise cutting on both strokes. It not only saves the

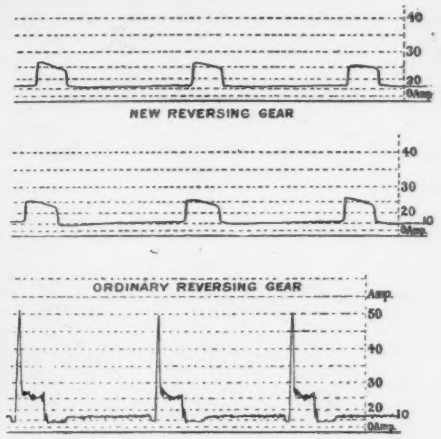


Fig. 28—DIAGRAMS FROM REVERSING GEAR

time spent on the idle stroke, but also the driving power that is expended in starting up the high speed of the return stroke, in arresting, and reversing it. Besides this the machine will do a larger quantity of work with a given amount of wear upon the guides if it is cutting on both strokes than if it is only cutting on one stroke and idling on the other. The incidental advantage of double cutting is that one tool chips away the scale at the corners, so that the other tool enters clean metal and

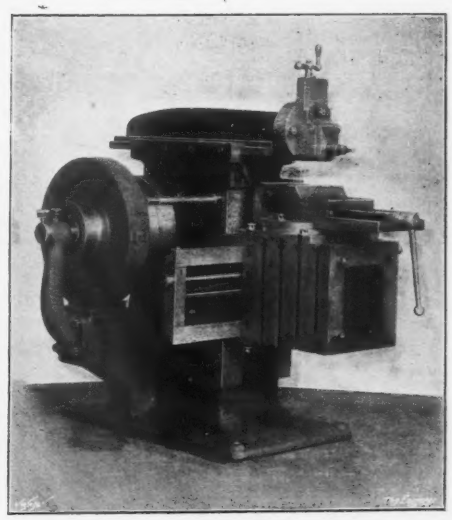


Fig. 29—SMALL SHAPER

performs the same good office for its companion by chipping away the scale at the opposite corners.

A good example of a standard type planing machine by this firm is afforded by the illustration on page viii. This machine planes 6ft. square and 18ft. long, with three tool-boxes. It is driven by Sellers' gearing, and the feed is given by a continuous revolving belt pulley, acting through a friction clutch and change

wheels, so that at each reversal of the machine the boxes receive the desired feed, and the same motion will travel the boxes continuously to adjust them to their work or will raise and lower the cross-slide. It will be understood that when double cutting is used the feed is applied at each end of the stroke. Without doubling the feed most of the advantage of double cutting is lost; but assume that a machine roughing over a casting with ⅛in. feed, then, with the double cutting and the double feeding, ¼in. wide will be planed over at each double stroke of the planing machine, instead of ⅛in. wide. With a properly constructed machine and tool-box, there is little doubt that the backward cutting tool is just as efficient as the forward cutting tool.

In the double cutting tool-box made by Buckton's the tools are back to back and are set down to the same level and follow in the same furrow, but each tool is fitted with a relieving tool-box, so that if ever it touches the work behind it it relieves itself.

A volume might be written on the patents which have been taken out from time to time for double cutting. Everyone remembers Whitworth's celebrated "Jim Crow" tool-box, in which the one tool turned round 180 deg. at each end of the stroke. This tool-box is still made and used, not only by Whitworth, but by others who have adapted the invention for application to plate edge planing machines, but it is obvious that while the "Jim Crow" tool is well adapted for work that gives room for turning the tool round at each end, it cannot be used except under these conditions. The same observation applies to a certain extent to back-to-back double tool-boxes, but in Buckton's box, at any rate, whenever the work does not permit the overrun of the tools, either the one or the other can be used by itself because it has a relieving action for the back run which Whitworth's "Jim Crow" had not. The time saved when cutting on both strokes compensates for the absence of the quick return in the special cases where only a cut on one stroke can be taken. Further than this, when only one cut has been taken, it is just as often taken on the return stroke, for greater convenience, as on the forward stroke; and although Messrs. Buckton have made many machines with an alternative quick or equal return stroke, yet on their standard types of machines they do not find the quick return stroke worth providing for, as well as the equal return stroke. They prefer to supply their machines either with double-cutting tool-boxes and equal speed on both strokes, or else with the ordinary single-cutting tool-box and a quick return stroke. When a quick return is preferred, the ratio may be anything for which the user is able to supply sufficient belt velocity. The machines of the size illustrated we have seen working well without bumping at a speed of 30ft. cutting and 120ft. returning.

Allusion has just been made to plate edge planing with a turn-over tool-box, as invented by Whitworth. Fig. 20 shows a plate edge planing machine with back-to-back tools on Messrs. Buckton's plan, instead of the ordinary turn-over tool-box. These back-to-back tools lend themselves with great facility for planing the edges of the plate at any desired bevel. It may be remarked that on these machines the holding-down jacks are alternately hydraulic and screw jacks. This facilitates the setting of a plate in the following way. The edge of the plate being inserted under the holding down beam, any one screwjack is pressed down to nip the plate in one position, but this does not pinch it so tight as to prevent the operator adjusting the plate with a mallet till he gets it into proper alignment. Having done this he opens the valve, and all the hydraulic jacks come down instantaneously and hold the plate securely for being cut. Another way of planing the edges of plates is upon a table planing machine. This enables both edges of the plate to be planed simultaneously, and, therefore, parallel with each other at one setting. A machine of this kind made by this firm has been found remarkably successful, and it is claimed that it halves the cost of plate edge planing where it is in use. It is driven by a moderate sized motor, and cuts at a speed of 35ft. per minute, but its success hinges very greatly upon the application of the double-cutting tool. It would not be economical to drag a 40ft. table back at a high speed by means of a powerful electric motor if it were doing no work, but as this machine is working continuously and the table is not travelled at more than 35ft. per minute

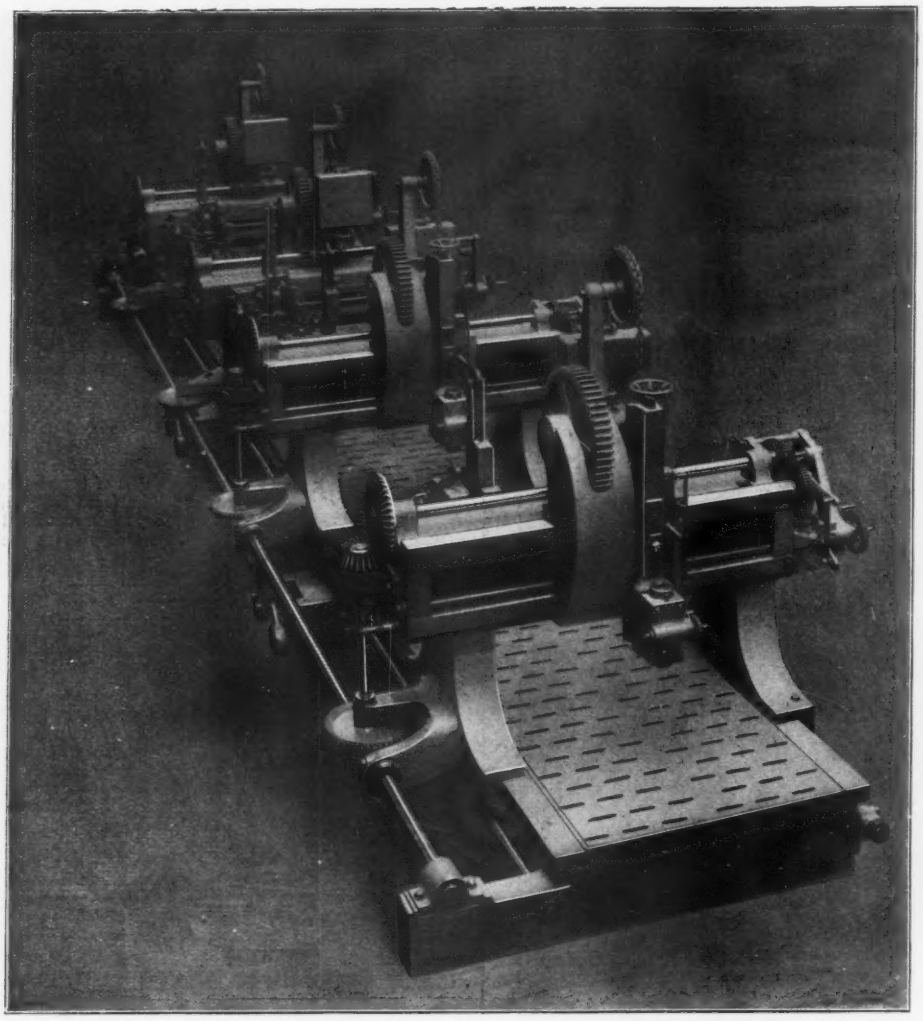


Fig. 30—HETHERINGTON'S FRAME SLOTTING MACHINE

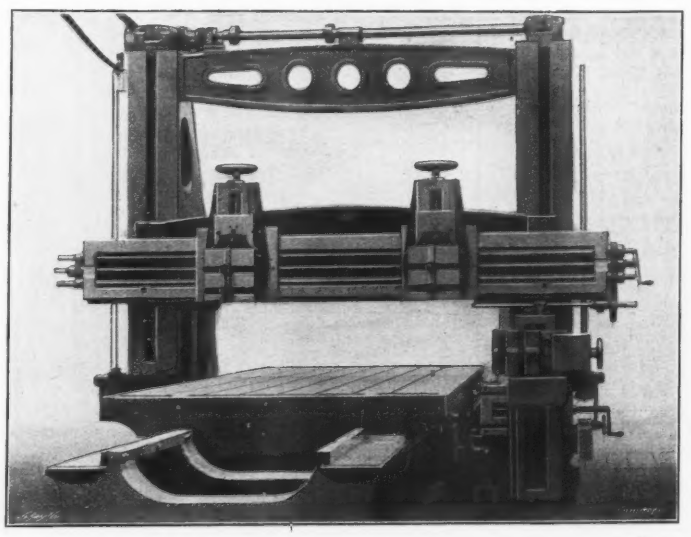


Fig. 31—PLANER WITH INDEPENDENT VERTICAL SLIDE

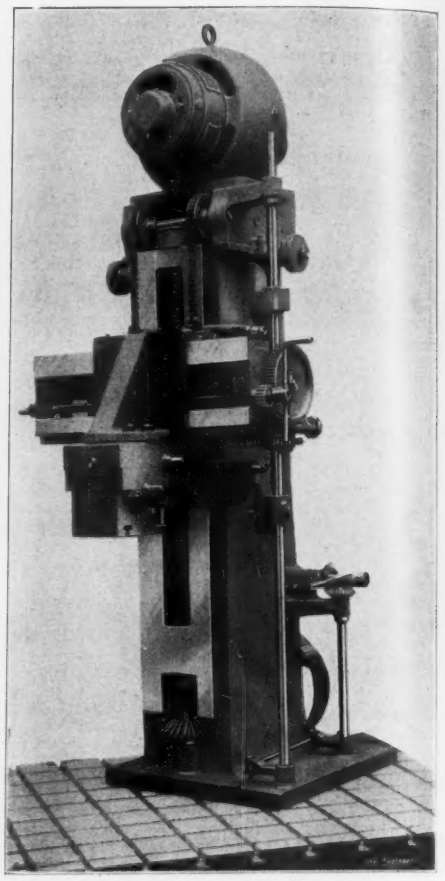


Fig. 32—PORTABLE VERTICAL PLANER

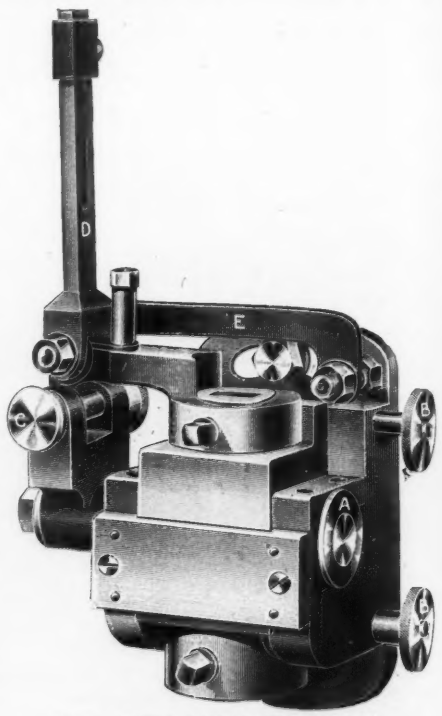


Fig. 33—WARD'S DOUBLE CUTTING BOX

it is, as a matter of fact, an economical machine in its working.

Whether planing machines should be made with the work to travel and the tool stationary, or with the tool to travel and the work stationary, is principally a matter of convenience. Fig. 9 shows a vertical and horizontal planing machine, in which the work is stationary and the tool travels. This machine will cover a surface 12ft. high and 12ft. wide. The vertical stroke is given by a screw, and the horizontal stroke is given by a pair of Sellers' spiral pinions, gearing into parallel cut racks. The base plate in this machine is the unusual depth of 2ft. 6in., and the whole machine is kept in true alignment by attachment to this strong, deep base plate.

Fig. 8 also shows a vertical and horizontal planing machine, but of a different type. It has a single standard, and is suitable for all work not exceeding 5ft. in height. The illustration shows the machine to plane 5ft. high on the slotting stroke and 10ft. long on the horizontal stroke. It is shown in its position in the works of the British Thomson-Houston Company at Rugby. On the left-hand side of the picture is a circular table, which can be placed on the machine when required for holding the work, which is revolved and slotted out with such a tool as is shown in Fig. 7. This figure is an enlarged detail of Fig. 9, and it will be seen that an essential characteristic of this type of machine is the freedom to get the long octagonal tool-bar across the saddle of the machine with a practically unlimited amount of inwards feed motion. The tool-box is not confined between the work and the framework of the machine, but passes across the face of the standard, and can project to any extent both back and front. The man also stands on the footboard, not confined between the work that he is planing and the framework of the machine. This machine planes cast iron at 35ft. per minute, and cuts on both strokes, whether cutting vertically or horizontally. The tool slide and saddle, being perfectly balanced, absorb very little power for the slotting action beyond that delivered to the cut itself.

It will be noticed that the machine is driven by two motors. One is against the wall driving up to a countershaft, and this is for the horizontal cut of the machine which reverses by crossed and open belts. Another motor is down on the floor at the right-hand corner, and drives through a horizontal belt on to a countershaft which runs along the gantry of the machine, and drives up by a vertical belt to the screw and gearing for giving the vertical action. The tool slide and saddle are balanced by a parallel system, so that whether the octagonal slide is in its extreme position inwards or outwards, and however it may be loaded out of centre by tool staffs or supporting brackets, the weight of the counterweight is delivered to whichever side of the saddle will balance it, and there is no cross action upon the guides. Messrs. Buckton believe that surfaces can be truly planed on this straight line vertical and horizontal machine at a cheaper rate for attendance and capital outlay than on any other type that only operates upon one surface. Of course, when the work permits of being operated upon on both edges simultaneously the design of the standard table planing machine has the greatest advantage.

Whilst we have double cutting under discussion a description of a new double tool-box recently brought out by H. W. Ward and Co., of Birmingham, may be given. This duplex tool-box, Fig. 33, is so constructed that, in addition to plain surface work being done, side cuts can be taken, angles and irregular forms planed, undercutting of T slots effected without lifting the tool, and, in fact, all work which can be done by the ordinary tool-box can be done by this one. The essential features of the invention are that the movements are obtained by means of a semi-rotary motion of the tool, which is effected by the movement of the tool-box on a vertical or horizontal axis—as shown in the illustration. The tool itself is a single one having two cutting edges—one front the other back. In the case of flat-surface cutting the tool-box swings on the horizontal axis, A, to a sufficient extent to allow of ordinary angle of relief being obtained. At the end of the stroke the box is tilted over a similar amount in an opposite direction by means of a rocking shaft actuated by the feed motion of the machine, so that on the return stroke the back face of the tool comes in contact with the metal to be cut and the front edge stands clear. The adjustment of the relative position of the cutting edges of the tool is rendered exceedingly simple by means of the milled-headed screws B B shown on the illustration; these screws adjust taper blocks behind the rocking tool-box, and so determine in a quick mechanical way the amount of movement in the tool block necessary to ensure both edges of the tool cutting the same depth. When vertical, angular, and under-cutting is done, the box is fixed so that it cannot vibrate on its horizontal axis, but is left free on the vertical axis, about which, by means of the rocking shaft before mentioned, the tool vibrates sideways at each end of the stroke of the machine. Similar adjusting pins C regulate the movement to exactly the amount required to enable both edges of the tool to cut the same depth. In undercutting T slots the tool is not lifted at all from the work, as is necessary on the ordinary machine. D is the rod for tilting the box E a flat spring for returning it.

Two machines built by Beyer Peacock will be found illustrated on pages v. and vi. by three engravings. They are a 9ft. by 4ft. 6in. by 4ft. 6in. planing machine and a double plate edge planer. A front view and a back view are given of the first. Two things strike one at once about it—first, the height that the table is raised, and second, that it runs on vees. The table is driven by a large screw running in a long gun metal nut. The screw is driven, as the back view on page vi. shows, by a worm and wheel—the former is steel, the latter of gun metal. Ball bearings take the end thrust of the screw and of the worm. This arrangement gives a very steady and powerful drive. The return is at four to one. Four tool-boxes are supplied, two on the cross slide and one on each of the uprights. There are the usual self-acting motion, and the refinement of a relieving gear for lifting the tools on the return stroke is also fitted. The external feed-gear is pretty clearly shown, the internal gear is of the American type, not very unlike that used by Darling and Seller, and described on a later page, but since the machine is screw-driven the motion has to be taken from an extension of the worm shaft—see the back view. The quadrant, driven from the picking discs, work the vertical feed of the boxes on the uprights.

The plate edge planing machine illustrated on page v., —Fig. 11—is an excellent example of this kind of machine. There are two beds capable of adjustment to or from each other each with a deep dovetailed shear on its side which carries a long saddle. The form of the saddle is well shown. It has two tool-boxes with self-acting feed facing each other, and the machine cuts, therefore, in both directions. The drive is by steel screws in long gun-metal nuts.

We illustrate on page x. a slotting machine by Butler

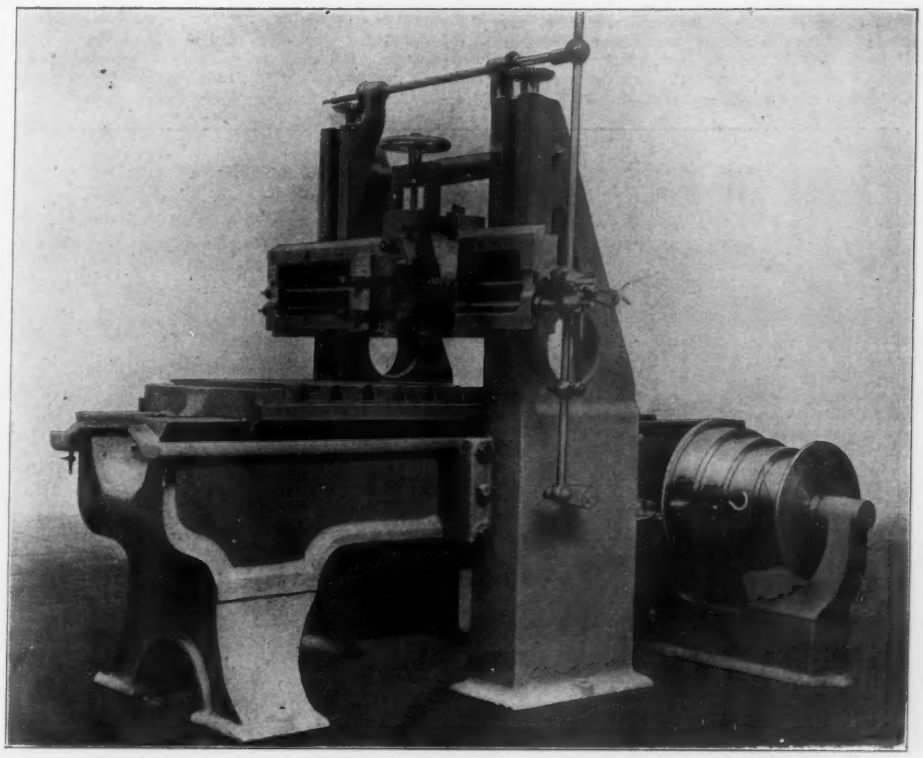


Fig. 35—DARLING AND SELLERS' LINK PLANER

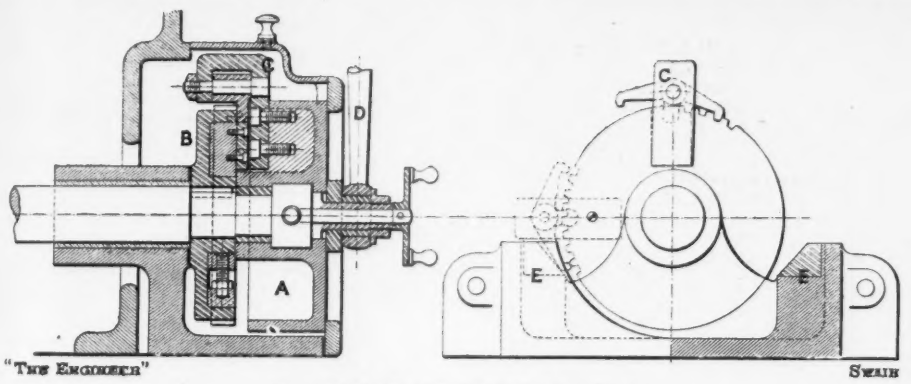


Fig 34—DARLING AND SELLERS' FEED GEAR

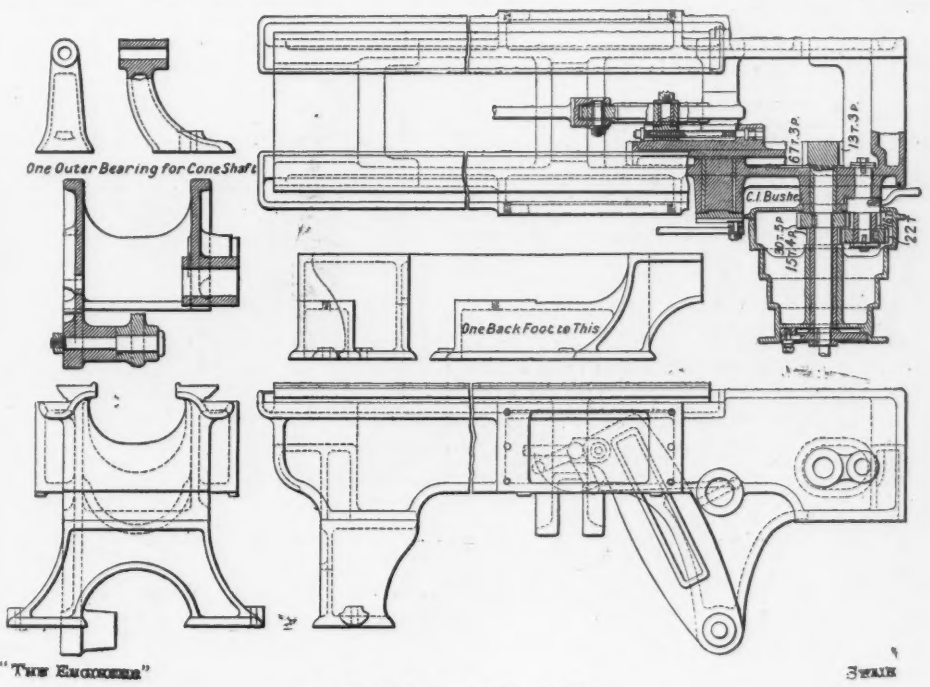


Fig. 36—DETAILS OF LINK PLANER

and Co., of Halifax, whilst the neat arrangement of the gear for driving the ram is seen in the drawing Fig. 23, page x. The object is, of course, to do away with all overhanging pins, and the drawings show very clearly how this has been achieved. A three-speed cone on the opposite side to that seen in Fig. 24 drives a cross-shaft which terminates in a heavy fly-wheel; this, by the train of gearing seen, drives a slotted link in the body of the machine, which is coupled to the ram by a short connecting-rod. The die which actuates the link is connected with two excentric discs fitted into the driving wheels on each side of the machine. By revolving these excentrics the die can be brought nearer to or further from the centre of the shaft, and hence the stroke of the ram may be altered. To facilitate this adjustment the excentric disc is graduated in inches. The position of the ram is regulated by a screw. It carries two forged steel tool-boxes, which are adjustable sideways in a slide. A compound table of the ordinary description, but extra wide, is fitted to the bed. The circular part is divided in two—an upper and a lower part. The face between them is slightly inclined, so that by turning the upper part half round the surface of the table is inclined. The amount of cant is $\frac{1}{8}$in. per foot, sufficient for slotting key-ways. By this arrangement the table is as well supported when inclined as when bedded down.

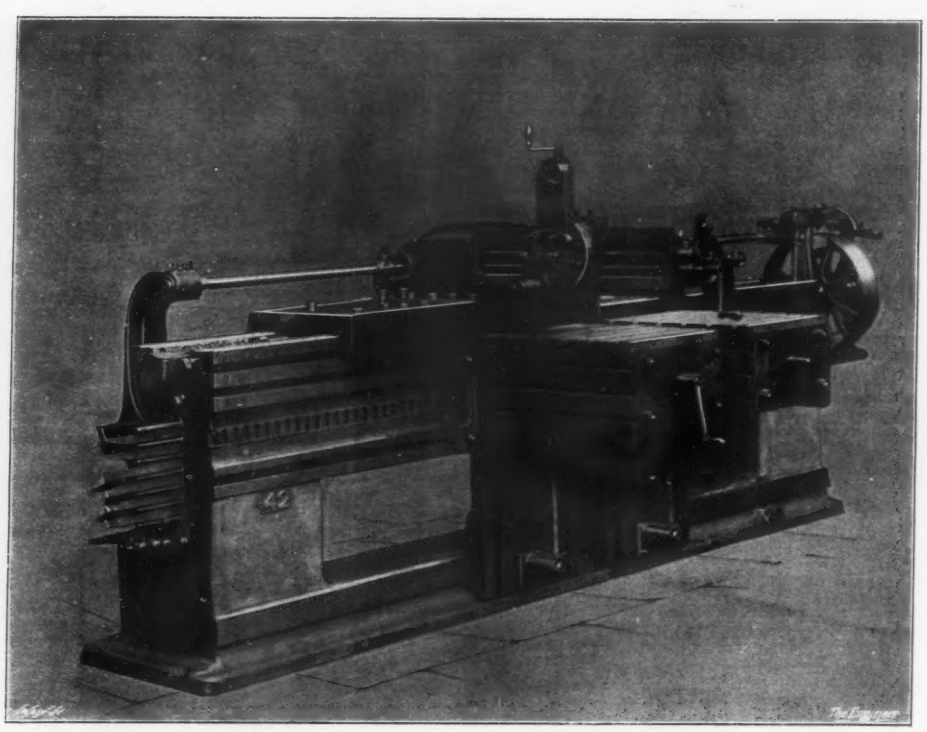


Fig 37—RICHARDS' SIDE PLANER

An example of an interesting device for getting over the trouble of reversing in reciprocating machines is illustrated by Figs. 25 to 29, page xi.

Briefly described, the device consists in a fly-wheel and shaft mounted in prolongation of the driving shaft, and kept in continuous movement by the back driving belt, so that when the back run is to be started a part of this fly-wheel's energy is gradually transmitted by a friction coupling to the main driving shaft, acting first as a brake upon the forward movement of the table, and then progressively increasing in effect until the whole power of the return movement has been applied softly and without shock, at which moment the reversed table itself starts the usual positive return motion in shifting the driving belt on to the back-motion pulley. In detail the arrangement is as follows, the reference letters given relating to Fig. 25. The short shaft *b* is fitted as a continuation of the driving shaft A. Upon the latter is fixed the forward belt pulley C, and on the inside edge of this last is mounted the loose pulley C^1 for receiving the forward belt when the machine is put out of gear. The back motion pulley *d* is fixed on the extremity of the main driving shaft A.

On the shaft *b* are fixed the back-driving belt pulley d^1 for the disengaged belt and a fly-wheel *e*. Belt pulley d^1 being considerably broader than the pulley *d*, a certain part of the belt when thrown on to *d* necessarily remains upon d^1. Between these two pulleys *d* and d^1 the cone *f* can be moved. In the inside of the back-motion belt pulley *d* is the hollow cone f^1, forming one piece with it, the friction cone *f* engaging inside the latter. A groove is turned around the inside of the cone *f* for the reception of tallow, which finds its way therefrom to the surface of the friction coupler, and these surfaces are kept cool by means of a fan formed in the end of the belt pulley d^1.

The device operates in the following manner:—The striking lever first throws forward the driving belt from C to C^1, and then presses the friction cone *f* into the counter cone f^1. The contact so effected at first brakes the acquired momentum of the travelling masses, and then starts the return course of the table, whereupon the peg X^2 on the table stop strikes the lever y^2, so throwing the back driving belt on to the back motion pulley *d*, while the cone *f* is pressed into closer contact with the hollow cone f^1. Reversal to forward motion is effected in the usual manner by stop X^1 and lever y^1.

The automatic records here appended from the ammeter of an electromotor driving a small planer will repay close examination. The planing table weighed 8818 lb., and while the diagrams were being made it was loaded with an iron casting of 4409 lb. weight; the cutting speed was 6·3in. per second and the back stroke 27½in. per second. Diagrams were taken with ordinary and with the new gear. It will be observed that in the former the power required to start the return motion was from 48 to 53 ampères, to accelerate about 24, and between 11 and 15 ampères to drive the table once the impetus had been given; while with the auxiliary reversing, at first 28, and then 24 to 26, ampères were required for starting and accelerating and 8 to 12 ampères for the driving, but almost imperceptibly augmenting by one or two ampères towards the end of the stroke when the braking motion was applied.

In light machine tools the arrangement has been much simplified by dispensing with the gear for throwing a back-motion belt on to a fixed pulley for the back motion, it being found all sufficient to merely transmit the energy of the fly-wheel to the driving shaft, as previously described, every advantage mentioned for the planer being retained in the smaller tools. A drawing is given of a shaper so fitted. Here the fly-wheel *e* is carried loose on the driving shaft, and driven by a three-stepped pulley, the purpose of the latter disposition being to enable the return speeds to be at once varied for the three different cutting speeds for which the machine is made. The usual adjustable stops on the slide effect reversal o forward and back motion.

These appliances are made by the Engineering Works of Chemnitz, Saxony, where they are also in daily use.

The machine illustrated on page xii. by Fig. 30 is to be found in the Great Western works at Swindon. It is the only representative that we can find space to describe of a very special and important class of tools used in locomotive works—the frame-slotting machine. A description is scarcely necessary. A pile of plates, of which only the top one is marked out, are clamped upon the long cast iron table, and are drilled and slotted out to the contour of the side frames of engines or tenders. For this purpose there are four travelling heads, with cross slides, cast in one piece, which are traversed, or fed, along the bed by gun-metal nuts, driven by carefully-cut gearing, revolving on two fixed square-thread screws, one on each side of the machine. One of these screws can be traced in the engraving Each head is fitted with a balanced slotting ram, driven by the powerful gearing shown, and a drilling saddle, which can be seen in the two more distant heads. These drilling saddles are fitted up like the most approved type of radial drill saddle, with reversing motion for tapping, quick traverse, automatic feed, and so on. They are powerful, since 2in. twist drills have to be used to take out the corners of the horns, these holes being afterwards slotted up. As radii have to be worked, an ordinary fixed tool-box is not suitable, and on these machines gear is provided for rotating the tool round its vertical axis, so that it may keep normal to the cut. The rams have quick return motion.

The machine is driven by a large three-step cone pulley at the far end, and each head is coupled to the drive by a friction clutch, so that the four heads are quite independent. To support the long shaft and the lead screws, tumbler bearings are provided. The engraving hardly gives an adequate idea of the size of the machine, which has a bed over 50ft. long by 7ft. 3in. wide, and can deal with plates 49ft. long. The rams have a stroke of 14in. This fine machine was made by John Hetherington and Sons, Limited, of Manchester.

Much has been, and a great deal more might be, written about portable machine tools. That they fill a very pronounced want is very clear from the popularity they enjoy. A machine that lends itself very well to portable construction and portable uses is the vertical planer, and we have, therefore, selected a tool of this kind, made also by John Hetherington and Son, for illustration, Fig. 32. As with nearly all portable machines, it is electrically driven the motor being conveniently placed at the summit of the column. It actuates a strong square threaded steel screw through quick reverse gearing. The screw drives a balanced slide with a compound tool-box mounted on it. This tool-box has automatic feed. The reverse is effected by cams upon the vertical reversing rod, the form of which is seen in the engraving. The machine illustrated has a stroke of 4ft., but a machine with a 9ft. stroke is also built. Its base measures 3ft. 3in. by 2ft. 11in.

Messrs. Darling and Sellers are perhaps better known as builders of gear cutters and powerful lathes than as makers of planing machines. Yet in this direction, too, they do some good work, giving attention—particular attention—to machines of small and moderate size, but not neglecting larger machines altogether. A small machine by them, which will be found interesting, is the link planer, illustrated by Fig. 35. This class of machine gets its name from the fact that the table is driven by a slotted link, much in the same way that the plunger of a shaper is driven. Obviously no great size is possible, both because of the impossibility of using gearing of this kind conveniently above certain very moderate dimensions; and, secondly, because it would, on account of the positive nature of the stroke, shake itself to bits in a very short time. But for a great deal of small work they are admirable, combining the stability of the planer with the absolutely fixed length of stroke of the shaper. Hence when there is but a limited amount of overrun of the tool possible, as, for example, when getting up the face for a steam engine slide valve, or machining seatings in a box, machines of this kind are invaluable. At the same time, of course, they can be used to advantage on ordinary work, and the very short stroke obtainable is not infrequently advantageous.

The general character of the machine illustrated will be obvious from the illustration. It is driven by a step cone, which permits of four changes of speed.

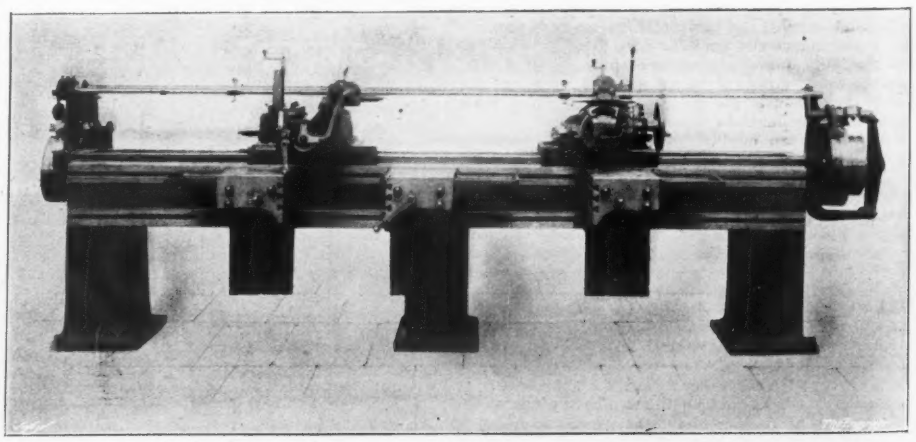


Fig. 38—RICHARDS' COMBINED SHAPER AND PLANER

Through intermediary reducing gear a crank is driven the pin works in a block in a slotted link, and the throw is readily variable. The feed gear is seen in the illustration. The maximum stroke is 2ft., and work 2ft. wide can be admitted between the standards. Pieces 1ft. 8in. deep can be machined.

In the pages of the number that accompanies this Supplement we illustrate a planing machine made by this firm, which we inspected recently in the maker's works. The feed gear of this machine is of the American positive kind already referred to. The feed wheel makes half a revolution at a time, and then stops dead. It is slotted, as the figure shows, so that the length of stroke of the

feed rod may be varied. Fig. 34 shows the details of this feed gear. Motion is imparted to the picking disc A by a ratchet wheel B, keyed on the end of one of the intermediate shafts for the table drive, which shaft rotates in one direction or the other, according as the machine is on its forward or return stroke.

The connection between the disc and ratchet wheel is either positive by a double pawl C pivoted on an arm attached to the disc A, or frictional by a suitably formed tappet or fork engaging with a central prolongation of the pawl. This fork is attached to a block which is mounted frictionally inside the ratchet wheel. The duty of this frictional connection is to engage the pawl at the commencement of the stroke, cutting or return, as the case may be. Once engaged, the disc is carried positively through half a revolution until the pawl is disengaged by contact with a suitable inclined plane EE in the gear-box. A connecting-rod D, the pin of which can be moved to or from the centre of the disc, gives motion to the feed gear.

The table is driven by a simple rack, but with a very large pinion, so that several teeth are always engaged. The reversing is of the ordinary kind, a cam plate striker being used, so that one belt leads by a small amount. For convenience of arrangement, the screws for elevating the cross slide are right and left-handed. In order to compensate for any slight error that there might be owing to this fact, any lack of harmony in their action, a compensating coupling is fixed in the horizontal shaft that carries the bevel wheels. It is a very simple device, but it permits of a useful adjustment being made. If the cross slide is found, owing to wear of the screws, for example, not to be quite parallel to the table, then, by advancing one of the screws by means of this coupling, parallelity may be regained. It is, of course, usual to clamp the slippers of the cross slide sideways against the standards before work commences, and this should bring it parallel to the table; but this adjusting coupling is such a small affair, and so far facilitates both erection in the first place and subsequent adjustment, that its adoption seems to be quite justified.

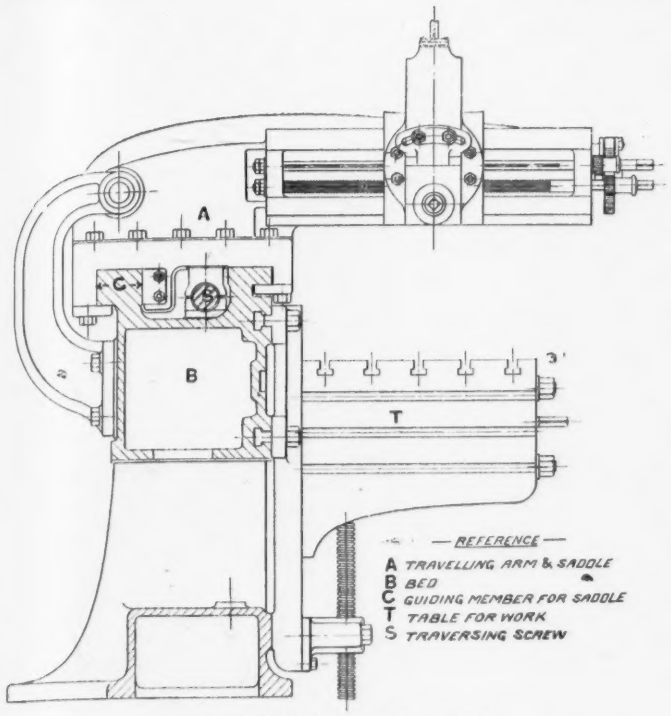


Fig. 39—SECTION OF SIDE PLANER

The bigger planer is driven by a triple-stepped rack; in both cases all racks and gears are machine cut.

A feature to which we wish to call particular attention is well brought out by Fig. 31. It will be observed that in place of mounting the side tool-boxes on the standards themselves, as is the usual practice, they are carried on independent vertical slides which can be moved horizontally to or from the table, so that the tool may be supported as close as possible to the work. Slides of this kind are sometimes put on one side only, the table being displaced from its central position to make more room for them; at other times the table retains its central position, but the standards are put unusually far apart to allow of a vertical slide being fitted on each side. Speaking of standards reminds us that Darling and Sellers have given special attention to the design of their castings. Some makers leave circular openings in the sides, others leave openings more or less rectangular. Darling and Sellers give the cross bars approximately the correct curve for withstanding thrust. It may be a small matter, but as they say, it is just as easy to make it right as wrong, and therefore why not have it right. The drive for these machines may be either in line with or at right angles to the machine.

We have already discussed pit planers; from them we turn naturally to side planers, which have a family resemblance, in that the tool is fixed in a cross bar, and travels over the work. Although there are several firms in this country who make side planers, we believe we are correct in saying that George Richards and Co., of Broadheath, have given more attention to their design and manufacture than any others, and we have, therefore, selected one of their latest machines for illustration. A view of it is given in Fig. 37, and a section of the bed and saddle in Fig. 39. It will be seen that the principle of the narrow guiding strip which John Lang and Co. first applied to a lathe has been adopted in this machine. Looking at Fig 39, it will be observed that the travelling arm A is supported by the whole width of the bed or shears, but is guided only by the narrow part G. We need not go into the advantage of a narrow piece, suffice it to say that since the guiding value, if we may so term it, is proportional to length divided by width, reducing the width has precisely the same effect as lengthening the saddle, and has obvious practically advantages over that course.

The position selected for the guiding strips in Richards' machine seems at first sight a little peculiar. It would seem more natural to select the front shear as a guide, since the pressure exerted on the tool tending to twist the saddle would act at a shorter leverage. But there is another way of looking at it, which will show the wisdom of the selected position. The traversing screw is shown in section at *s*. It holds a mid position between the point of resistance, that is, the tool and the guide. Now, the resistance is always trying to drive the arm backwards, tending to cause it to rotate round *g*, whilst the screw is pulling it forwards, trying to keep it straight on *g*. To bring out this point more clearly, imagine for a moment that the front shear had been taken for the guide. We should then have had the screw helping the resistance to twist the saddle on the bed, and binding would have occurred. The question as to the best position of the screw is complicated by various considerations of convenience of design. Obviously the best possible position for it would be always right under or over the cutting tool, an obvicusly impracticable situation. The nearer it can approach this place the better. It would, for example, be more efficiently placed in front of the front shear, but it would then rob space from the table, and the arm would have to be lengthened to make up for the loss, thus coming back to the point left. If all the considerations are summed up, it will be found that there is no other possible position for the screw than that shown. It will be observed that it is put as close up to the front shear as the design allows. We have gone into this question with some care, because the principal objection that has always been urged against side planers is the ricking action due to the pressure on the tool at the end of an overhung lever. We have not yet had an opportunity of testing figures of a machine built on this new plan, but from purely theoretical considerations we are confident that it will be found to be a marked improvement on the old method.

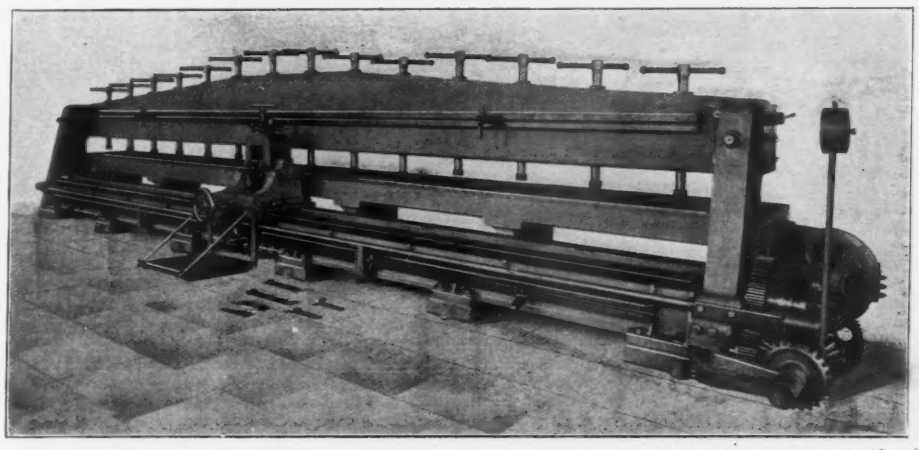


Fig. 40—ELECTRICALLY DRIVEN PLATE EDGE PLANER

A large variety of machines of this kind is made. They are made to plane a maximum surface 24in. long by 12in. wide, and to plane 30ft. long up to as much as 48in. wide, two tool boxes on one arm or two arms being used. We have already discussed the points in favour of the pit planer; they apply equally to this class of machine, to which there is only the objection to the overhang of the arm, and this does not seem to have any foundation when practical work is considered. They are driven by belt without gearing, and have a reverse speed of four to one. Since they are screw-driven the point of arrest is clearly marked, and the length of stroke is almost as positive as that of a slotting machine. In all except the smallest machines the starting and stopping gear is brought to the front of the arm, where it is easily manipulated. In the machines fitted with two arms all the motions are quite independent. The tables can be removed bodily from all machines, and by providing a pit in front quite large work may be planed.

Besides the simple side planer, Geo. Richards and Co make a combined planing and shaping machine of the kind illustrated in Fig. 38. Here, at the left hand, is a planer arm, and at the right a shaper head. They are driven quite independently, the planer screw passing through the bed of the machine, whilst the shaper shaft is fitted at the back. The planer returns at four to one, the shaper at half that speed.

There is a very interesting machine of this kind in Tangyes' works at Birmingham, and which was made there. It is a large machine with two heads, both of which may be used as shapers or side planers. In each of the saddles is fixed a heavy ram, which is moved in and out fast when shaping, or slowly to effect the feed when planing. On the end of each ram is a tool slide, with a swivelling tool box, and down feed screw. The tool box is fastened to the end of the ram by a large vertical pin or hinge, so that it may be swung into either one of two positions at right angles to each other. It is

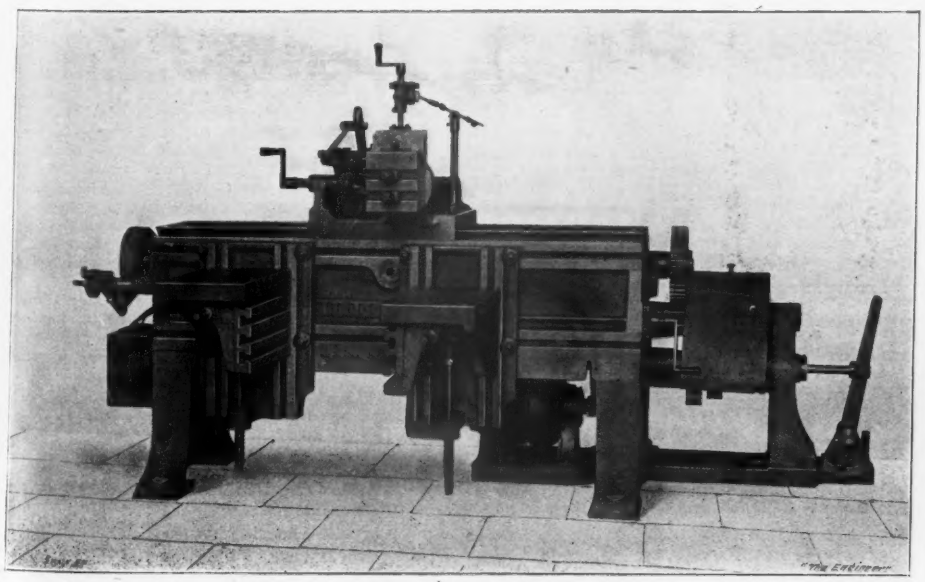


Fig. 41—WILKINSON'S ELECTRIC SHAPER

made fast and solid in the desired position by bolts in T slots. For planing, the tool slide is fixed on the side of the ram; for shaping, it is made fast at the end. By this ingenious arrangement the machine can be instantly converted, no special tool boxes being required. We do not know that more than one machine of this pattern was ever made.

Whilst we are describing side planers, mention may be made of a scarfing machine for ship plates constructed by George Richards and Co. It consists of two side planers put facing each other, and connected by two swivelling tables for receiving the plates. The arms will plane 7ft. long, and one will cover a width of 27in. and the other 30in., the difference allowing the longer arm to deal with the central scarf. The saddles are driven by steel screws 3½in. diameter, fitted like all these side planers with thrust bearings.

Two reciprocating machines, electrically driven by motors neatly included in the general design, are illustrated by Figs. 40 and 41. They were made by George Wilkinson and Sons, of Keighley, that hive of machine tool makers. In both machines the drive is positive, and as it is not practicable yet to make a reversing motor for such work, a reversing motion has been included in the train of the plate edge planing machine. It takes the usual form—a pair of mitre wheels and a clutch. This machine cuts on both strokes, which are consequently made at the same speed. The saddle is moved by a screw inside the bed. The gearing and the reversing motion are well shown by the engraving. The tool-box is of the turnover kind; it has automatic down feed, and the vertical slide on which it is carried may be swivelled for planing bevels; transversely it is adjusted by a hand wheel. The construction of the table and beam is obvious.

The motor is triphase, periodicity 60, the power 4 brake horse-power at 550 volts and 840 revolutions, which gives 16ft. cutting speed per minute. The switch is mounted on the end of the machine. The machine will plane at one setting a length of 25ft., and a pile of plates amounting to a total thickness of 7in. The driving screw is 5in. diameter, and is double threaded, with a 2in. pitch.

The motor for the shaper is of 2 horse-power, at 460 volts. It is placed under the bed and is connected with the driving shaft by means of a train of gearing that permits of four changes of speed whilst the machine is in motion. The saddle has automatic surfacing and vertical feeds, and a handle placed on it permits of it being moved rapidly along the bed. There is also automatic circular feed. The tool-box can be set for shaping at an angle by an index on the ram. The two tables, adjustable along the bed, are raised and lowered by screws and handles. The ram has a quick return motion and is adjustable for position and stroke. The maximum stroke of this shaper is 14in., the length of the ram is 2ft. 10in. The saddle can traverse 4ft. 4in. along the bed, of which the total length is 6ft. The wheels of both these machines are, of course, machine cut.

We have had such a large number of British machines to deal with that it has not been possible to find as much space for foreign tools as we should have liked. In order, however, that America should be represented, we have selected two machines built by the Niles-Bement-Pond Company, of Hamilton, Ohio, and 23, Victoria-

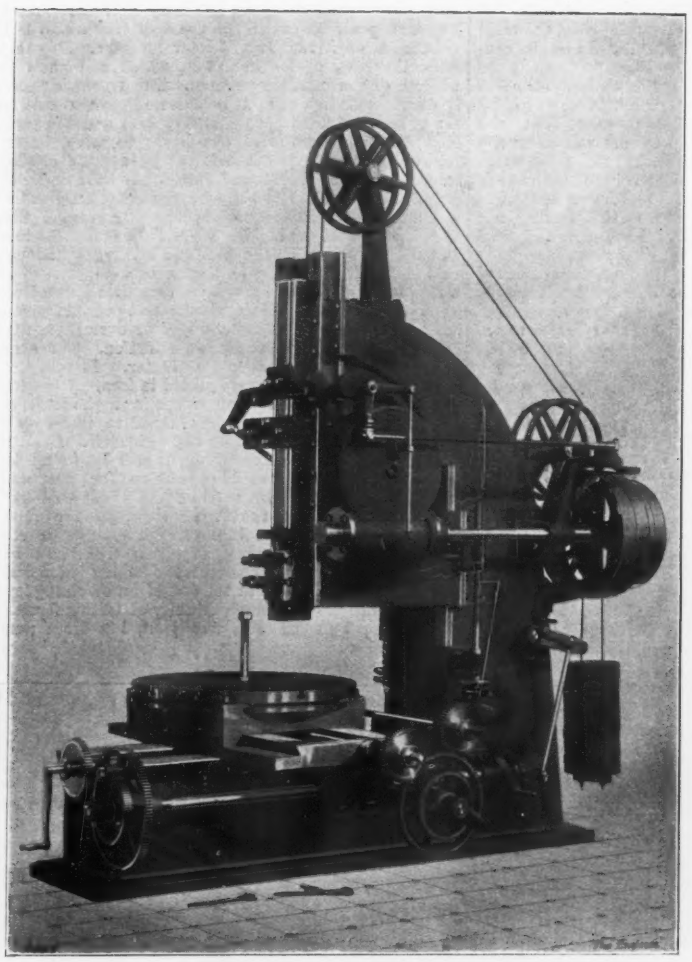


Fig. 42—NILES 24in. SLOTTER

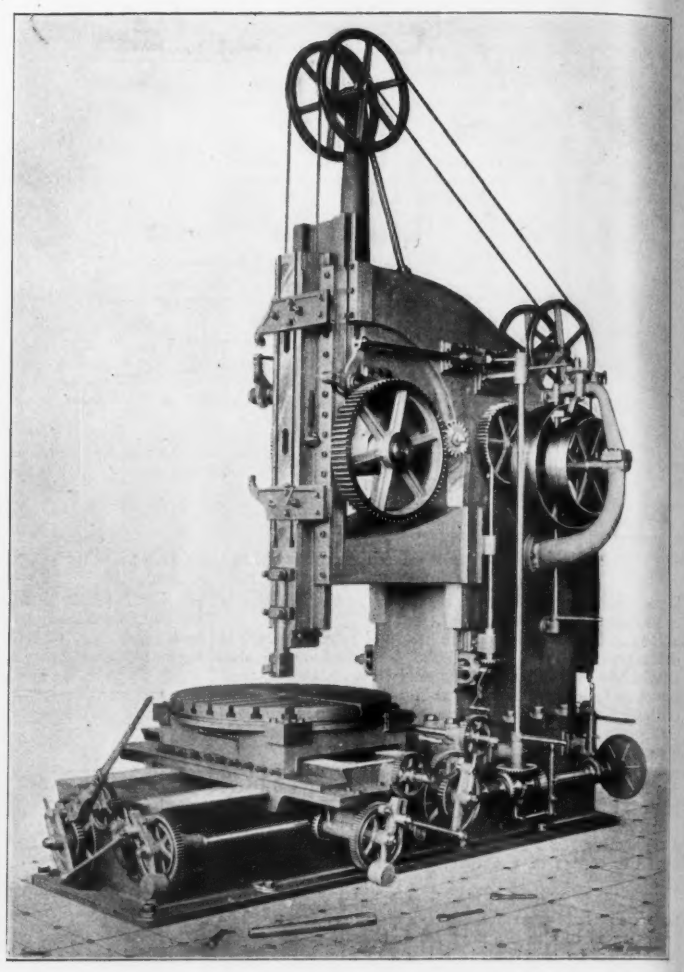


Fig. 43—NILES 54in. SLOTTER

street. They are both powerful machines and of large size. Both are slotters; the larger has the abnormally long stroke of 54in., the smaller 24in. The rams are driven by rack and pinion in the smaller machine, through the intermediary of worm gearing. They are carried in long slides, which are adjustable vertically so that the tool may be supported as close up to the work as possible. The tables are compound, with full automatic movement, and power adjustment for all directions. The bigger machine will take, we are informed, a 3in. cut with a ⅛in. feed. For work that can be fixed outside the ram a stroke nearly 9ft. long may be taken on the 54in. machine, and 50in. long on the 24in. machine. A good deal may be learnt from a careful study of the engravings. Judging by the narrowness of the driving pulleys, a very high belt speed must be employed.

NEW FORMS OF THE STEAM TURBINE.

By ROBERT H. SMITH.

No. I.

PROFESSOR DR. RIEDLER, of pump and other fame, has been holding forth last month in Berlin to the Technical Shipbuilding Society (Schiffbautechnischen Gesellschaft) upon steam turbines. He is emphatic that the steam turbine is going to revolutionise power generation. He leaves a place in future history for power gas engines, but none for piston steam engines. To show how completely he has made up his mind on the subject, we will, in the first place, quote literally some of his sentences, guaranteeing that the context does not materially modify their force and meaning.

"The normal piston steam engine is no longer capable of material improvement either in respect of mechanical construction or of thermal action. A complete transformation of the steam engine into the new form of steam turbine is essential. . . . Turbines are much cheaper than piston engines, require less room, hardly any attendance, and use no more steam than the best piston engines. . . . The results of the last ten years' trials indicate that the turbine is the simplest and the best form of steam engine. . . . The costs of erection, &c., are very small, and the bulk is from $\frac{1}{4}$th to $\frac{1}{10}$th that needed by a piston engine of equal power; they require no foundation, no fly-wheel, no added "balance-weights;" they have no dead points, and can be started equally well in any position of the shaft. They have no parts sensitively liable to leakage, and start as well cold as hot. . . . They have no internal moving parts which require lubrication. The wear of the shaft bearings is due only to the steady weight of the wheel, and not to any of the working forces. . . . Internal-combustion engines have beaten steam engines because they give a doubly better utilisation of the heat of combustion of the fuel; but only where waste gases are obtainable, as from blast furnaces and coke ovens, or where power-gas is cheap. Therefore steam engines will be superseded by gas engines at ironworks, many coal mines, and certain special workshops. This development has already in large degree begun in the ironworks of the Rhine and the Moselle valleys. The gas engine would extend much beyond these limits in replacing steam engines if it did not meet a new rival in the steam turbine. . . . The use of steam turbines is thus a problem of the highest order, and of the greatest technical and industrial significance; it is the greatest reform since the introduction of steam-power. In steam turbine development Germany has unfortunately hung back, and is in danger of being out-distanced by other countries. At least two years of strenuous work will be needed to make up the start she has allowed England and America to obtain. No tariff is high enough to make up the difference between the prices of equally powerful steam turbines and steam piston engines. It is not a problem for future speculation and improvement: it is a weighty question of the present."

Dr. Riedler is justly severe upon those ignorant laymen who talk of competition between electric and steam power. Over three-quarters of our electricity is generated by steam power; there is no present prospect of industrial generation of electricity direct from chemical action; electricity has become a chief, if not the most important, customer of steam power makers. He also lays special stress upon the field for steam turbines in ship propulsion.

It is thus apparent that Professor Dr. Riedler has burnt his boats, and every one will admit that he stakes a great reputation both as a practical mechanician and as a theoretician. It will, therefore, be interesting to examine in some little detail the grounds of these very confident anticipations. The more so because, while the de Laval and the Parsons are the only turbines most of us have heard anything about, Dr. Riedler has no belief in either of these two satisfying the requirements of the future—those the fulfilment of which is the condition of beating the piston engine out of the field.

Dr. Riedler begins by defining the fundamental distinction between piston and turbine engines, namely, that the former spends the pressure potential energy of the working fluid, whether this be water, steam, or gas, directly in pushing the piston along its stroke; while in the other kinetic energy only of the working fluid produces the driving effect. In the former, on account of the accelerations of the reciprocating masses, the mean piston speed cannot be made more than from 2 m. to 5 m. per second. In water the velocity of a jet due to the highest falls does not exceed 100 m. per second; but when one uses steam as the working fluid, its small specific weight leads to a velocity of over 1000 m. per second = say, 2300 miles per hour, in the issuing jet with quite ordinary boiler pressures. The difficulty is to extract with fair efficiency the kinetic energy from so rapid a stream.

According to Riedler, there are two ways of extracting this energy. First, by the back pressure of the outflowing jet, called the "pressure" or "re action" principle. To get perfect, or unit, efficiency on this principle, the peripheral velocity of the wheel must equal the full velocity of the jet, so that the steam would be left behind with zero velocity. With 8in. to 12in. diameter, this would mean a rotational speed of 100,000 turns per minute, any approach to which speed is physically impossible. This first principle of application is, therefore, of no mechanical utility.

The second method of application is referred to by the name "action" or "impulse." The kinetic energy is generated in the jet before it enters the wheel, and is destroyed by impact upon the moving blades. The speed required for complete, or unit, efficiency is reduced to half that needed by the first method. Steam turbines are as different from water turbines acting on this same base principle as are the physical characteristics of small density steam from those of dense water. In consequence of its extremely small density, the jet requires the most rigid control to prevent side dispersion and proportionate loss.

Dr. Riedler then compares the progress made by piston steam engines in two hundred years with that made by steam turbines during the last thirteen years.

The losses occurring in the conversion of steam energy into mechanical work are of two main kinds—leakage and heat losses. Dr. Riedler says that modern piston engines can be made perfectly tight against leakage in pistons, valves, and glands in permanent running. He says that heat losses, however, cannot be avoided, and can at best be minimised by increase of speed, by decrease of cooling surface, by heating of cylinder walls, &c., and especially by the use of superheated steam. In these respects modern construction has done all that can be done, and thus no further important improvement remains possible.

On the other hand, in turbines he declares it to be easy to avoid heat loss if only the wheel be run at high speed and the high-temperature steam be brought in contact with only a small extent of cooling surface. It must be remembered that as soon as its energy is converted to the kinetic form, it has already become cold; that is, with ordinary vacuum something like 150 deg. Fah. But the most rigid guidance of the jet is required to avoid loss by dispersion into ineffective paths and dissipation in cloud or "dust." Losses of this sort are classed under leakage losses.

Dr. Riedler then offers a well-deserved tribute to the Swedish engineer de Laval, who is the creator of the practically useful steam turbine. The de Laval turbine has been completely described in the pages of THE ENGINEER. The magnificent refinement and simplicity of its design and the practically perfect workmanship put into its construction make it probably the most admirable and most beautiful machine ever built by engineers.

But direct coupling with such high rotative speed as this engine needs to any class of industrial machine is impossible. Hence the extraordinary 10 to 1 tooth-gearing reduction in the standard de Laval—an oblique or spiral spur gear, extraordinary in the excellence of its workmanship and in the smoothness and silence of its running; but, unfortunately, also so extraordinary in its proportions that every practical man is instinctively afraid of the cost of its upkeep. This gearing occupies more bulk than does the turbine itself. Moreover, the system has been found impracticable for larger units than 300 horse-power.

Dr. Riedler next discusses the Parsons solution of the problem, which, he says, works partly on the "pressure," or "re action," and partly on the "action" or "impulse" system; the chief practical advantage of the system being, however, the lowering of the speed by breaking the whole fall of pressure into a large number of steps. Each part-fall of pressure creates velocity and kinetic energy, which, however, is extinguished again by work done on the wheel before the next pressure-fall and corresponding increment of velocity takes place. The rotational speed is thus lowered to from 500 to 3000 revolutions per minute. The upper limit of speed is determined by centrifugal force stresses; the lower limit by "practical aims, by difficulties and losses." The turbine shaft may be direct-coupled to that of the driven machine.

The construction of Parsons' turbine has been frequently described in THE ENGINEER and elsewhere. Some of the objections to it are enumerated by Dr. Riedler. With high-pressure steam the number of running wheels and intermediate fixed guide-wheels is large, and each contains a great number of blades; so that the total number of blades in a turbine runs from 40,000 to 80,000. This large multiplication of parts is unavoidable, because the fall of pressure in a single step must be small, not only to attain the desired low speed, but also to avoid inordinate loss by leakage outside the peripheries of the running wheels, and inside those of the fixed guide rings. Prevention of such leakage is impossible, and the smaller the clearance left with the object of lessening the leakage, the larger is the viscous resistance to the rotation of the wheel. This viscous resistance is experimentally proved to be much the largest of the mechanical losses in steam turbines. It becomes small only when the wheel runs in a good vacuum, and the ground principle of the Parsons construction negatives the possibility of all but the last one or two wheels running in such vacuum. Moreover, the clearance has practically to be made greater than would otherwise be necessary by the unequal expansion of the parts, the clearance necessary throughout being what is required by the worst of 40,000 to 80,000 parts, which cannot be manufactured with exactitude to equal dimensions and equal quality of material; $\frac{1}{4}$ mm., or $\frac{1}{100}$in., is the smallest clearance that has been found practicable on the Continent; and this must evidently be reckoned on for the hottest temperature ever arising in the machine. The turbine shaft and blade-wheels upon it are long and heavy; they cannot be otherwise, there being some hundred wheels, and a like number of guide-rings, besides the numerous "labyrinth balance pistons." These have to be made so stiff that the deflection under their own weight is negligible, and the bearings must be so constructed that their wear will not disturb the above exact small uniform clearance round the periphery. Neither must any measurable deflection arise from centrifugal force and want of perfect balance. Various devices have been tried in the Parsons turbines for giving the bearings a small degree of lateral mobility—of automatic side-adjustment—to allow the shaft to take up its own axis of rotation in accordance with its centre of mass, it being impossible to get this centre of mass dead true in the geometrical axis. It is doubtful whether any of these devices have been effective in the way that the Laval flexible shaft undoubtedly is; but, in any case, this lateral play given to the bearings necessarily increases by just so much the leakage clearance that must be left at the periphery. The difficulty of the true adjustment of the leakage fit is increased by the necessity of constructing the casing in halves, so that the top throughout the whole length may be lifted away for inspection. The long joint between the two halves is an expensive one to make, and expensive also to maintain to the requisite exactitude. Dr. Riedler says that the mode of construction of Parsons wheel and shaft leaves it impossible to get such balancing as will prevent serious centrifugal forces acting. In summing up, he says that in this turbine friction and wear is diminished in proportion to the decreased speed of rotation, but increased in proportion to the much greater weight and length of the shaft than in other turbines.

Except for ship propulsion, where it can be utilised to take the propeller thrust, the very heavy axial steam thrust in the Parsons turbine is a source of extra cost both in construction and in running, unless the symmetric duplex Westinghouse design be adopted. The "labyrinth" balance pistons add weight and length to the shaft and materially increase the viscous or frictional losses. Finally, Dr. Riedler points out that the Parsons turbine is in its essence deprived of any means of varying horse-power and speed independently, except at the expense of excessive loss of efficiency. If an altered horse-power be obtained by altering the initial steam pressure without altering the speed, then the dynamic and thermal elements of the design are thrown altogether out of harmony; the machine no longer works correctly, even to a rough approximation. The same dynamic disorganisation immediately arises so soon as the correct normal speed is departed from up or down without change of initial working pressure. Thus, the only way of maintaining moderately fair efficiency with varying horse-power is to vary both working pressure and speed together according to some rather complicated law.

Such is the formidable list of objections brought against the Parsons turbine, which, nevertheless, it is admitted has attained a wider popularity and a more extensive practical utility than any other so far.

The Rateau turbine is a development of the Parsons in the direction of decreasing the leakage in each step by extending each guide ring in the form of a diaphragm inwards to touch a relatively small-sized shaft. Thus the fall of pressure in each step can be made much greater, and the number of wheels and guide rings correspondingly reduced to one-third that in the Parsons. This is a great simplification, but it is obtained at the expense of much greater viscous and frictional loss per step. Another improvement in the Rateau is that in the first wheel admission takes place over only a fraction of the periphery, the peripheral proportion of admission being gradually increased from the first high pressure to the last vacuum stage. This partial admission necessitates the whole drive being on the "impulse" principle. The larger pressure fall per stage puts up the efficient rotative velocity to some one and three-quarter times that of the Parsons, and the introduction of the diaphragms—which need to be in halves, close-fitted together—makes the whole less accessible for ready inspection.

After a few remarks upon the Zoelly turbine, Dr. Riedler passes to an exposition of the efforts made by Professor Stumpf and himself to find a construction which will eliminate the disadvantages inherent in the two extremes represented by de Laval and Parsons. The statement of the ground principles on which they set out on this quest is very interesting.

Firstly, they set definitely aside what is called "re-action" working, the reason given being that this requires double the wheel-velocity needed by "impulse" working. That is, they adhere to the general principle of the de Laval and Pelton wheels. Parsons wheels are supposed to act partly by "re-action." To utilise the impulse principle in a practically useful manner they lay down the following four essential conditions:—

(1) The wheel diameter used with single-stage working must be so enlarged as to obtain practically useful rotational speed—*i.e.*, about one-tenth the Laval speed—combined with correct ratio to the steam jet velocity.

(2) By splitting the fall of velocity—*i.e.*, the spending of kinetic energy—into stages, a further reduction to from 500 to 700 revolutions per minute is to be reached for the many applications where so low speed is needed.

(3) Combined staging must also be arranged for, in which both the total pressure fall and each velocity fall are split into distinct parts or steps—always, however, under the condition that the number of separate pressure falls shall be small.

(4) In all cases there must be fulfilled the requirements of practical economical construction and of efficient inexpensive running.

Beyond the gradual thickening of the disc towards the central bore, Laval has not attempted to solve the problem of making large wheels to run safely at high speed. Nevertheless, wheels of from 2 to 3 metres, or 7ft. to 10ft., diameter can be made for 1500 to 3000 revolutions per minute, giving, say, 1000ft. to 1300ft. per second peripheral speed. For success in this direction, four things are necessary. One is a close scientific analysis of the stresses caused by centrifugal force, and of the disposition of material to resist these forces so that all the material may be utilised up to its full limit of strength. Such an analysis has been achieved only within the past few years in a complete form, and the economy of material resulting from it has raised the safe speed (of correctly designed discs) two or three-fold. The term "economy" has here a meaning apart from money cost: it is mass that creates these stresses, and it is the *saving of mass* in proportion to the sections supporting the stresses that makes the higher speed safe. The second condition of success is the use of the highest quality of material in respect of tensile and shearing strength and in respect of reliability. As the exact centering of the centre of mass in the rotative axis is of extreme importance, material subject to blow-holes is inadmissible. Laval used cast steel, which is objected to by Riedler. He states only that the Stumpf-Riedler discs are usually "of steel," and for extra high speeds of nickel steel (10 per cent.). Presumably they must be either forged, or else subjected

hot to heavy hydraulic pressure after or during casting.

The third necessity is the most careful workmanship. The discs are turned dead true and smooth all over. The smoothness of surface is of importance in minimising the viscous and frictional resistance to running at high speed through steam enclosed in the casing with small clearance between walls and wheel. The "buckets" are tooled out of the solid rim; they are milled out, and however many milling tools may be simultaneously at work at points round the periphery of the wheel, it is easy to ensure exact central symmetry in cutting all the buckets. With this method of manufacture—which, taken per bucket, seems an expensive one—it has been found easy to reduce the error of centralisation of total mass to $\frac{1}{100}$ mm., or under $\frac{1}{2500}$in. Large-sized wheels give, in a not unimportant degree, a better economy of material than do small ones, so that for the same peripheral speed, at least up to certain limits, large diameters give a larger factor of safety than do small ones. Seven-feet wheels of nickel steel, running at 3000 revolutions per minute, can have a five-fold factor of safety.

The fourth necessity is the careful and rigid control of the dynamic action. The exact centering of the mass already referred to is the first element in this control. But an important point is that while the centrifugal stresses are here almost infinitely more dangerous than all others, they are capable of rigid and exact calculation; they cannot be other than has been reckoned for. A still more advantageous feature is that these stresses remain absolutely "steady" so long as the speed is unchanged, and the speed cannot change quickly. The stresses are "quiet," which is well understood to be the stress condition most favourable to strength, and is right at the other pole from that of the working parts in reciprocating engines. This advantage applies not only to the moving parts, but also, and quite as much, to all the fixed parts making up the casing (or cylinder), frame, bed-plate, &c., of the machine.

THE LIMITS OF WORKING STRESS IN BRIDGES.

No. IV.*

AT the end of the last article on this subject we discussed the report presented by Mr. Max Edler von Leber to the International Railway Congress of 1895, and commenced to give a list of the limits of working stresses adopted in various countries. This list is continued and concluded below.

Russia, 1888.

Limits for mild steel according to span:—

	Girders.		Wind.		Shearing force.
	Chords.	Lattice bars.	Tension	Compression.	
Plate girders up to a span of 50ft. ...	4·13	—	—	—	2·39
Girders from 30ft. to 105ft. in span ...	4 59	4·59	5·71	5·08	2·70
Girders of more than 105ft. span	4·91	4·71	6·03	5·40	3·01

All in tons per square inch.

France, 1891.

	Tons per square inch. Wrought iron.	Mild steel.
Main girders up to 30 m. (98ft.)	4·13	5·40
Longitudinals and transverse girders ...	3·48	4·78
Parts subjected to alternate stresses ...	2·54	3·79
Main girders of more than 30 m. (98ft.)	5·40	7·30

For wind take 1 kilogramme (1400 lb. = 0·63 ton) more.

England, 1892.

The Board of Trade keeps for steel the limit of 6·50 tons. For the Forth Bridge the limit was raised to 7·50 tons. An extract from one of Sir Benjamin Baker's specifications is given as follows:—

	Tons per square inch.
Plate girders, main girders, transverse girders, and longitudinal runners... ...	4·50 to 5·50
Main lattice girders...	5·50 to 7·00
Wind bracing for all spans	8·50
Shearing stress on rivets	5·00

For wrought iron 90 per cent. of these values are allowed.

Switzerland, 1892.

Wrought iron

$$4{\cdot}42 \text{ tons} \pm 2\frac{f \text{ min.}}{f \text{ max.}} \text{ per square inch;}$$

mild steel

$$5{\cdot}08 \text{ tons} \pm 2{\cdot}5\frac{f \text{ min.}}{f \text{ max.}} \text{ per square inch;}$$

for wind pressure 1420 lb. (0·63 ton) more, and for shearing stress 10 per cent. less. The regulations also contain fixed formulæ for compression members to provide against buckling.

Italy, 1892.

No limits have been fixed uniformly by the Government. For wrought iron the old coefficients of 3·81 tons and 4·44 tons are allowed. For the steel bridges constructed by the Mediterranean Railway Company:—

	Tons.
Chords of main girders	6·34
Web-bracing of these girders	5·08
Uprights over the supports...	3·17

Germany, 1895.

In Saxony in 1885 the Launhardt-Weyrauch formulæ came into use, but afterwards the "limits depending both on the moving load and the dead load" came into force again. In Bavaria the Gerber formulæ came into use a few years before 1895.

The Bromberg—Prussia—administration in 1892 allowed:—

	Wrought iron.	Mild steel.
For transverse girders and longitudinals	3·81	—
For main girders...	4·76	—
For wind pressures	6·99	—
For main girders of 129 m. (423ft.) ...	6·34	7·62

The Hanoverian—Prussia—administration allowed in 1895:—

	Wrought iron.	Mild steel.
Transverse girders and longitudinals ...	3·81	4·44
For main girders...	4·76	5·71

The reporter proposed the following as the limits to be adopted, with the usual rectilinear interpolations for intermediate spans:—

Spans.	Wrought iron.	Mild steel.
0 m. (0ft.)	4·44	5·71
40 m. (130ft.)	4·96	6·05
80 m. (260ft.)	5·33	6·61
120 m. (390ft.)	5·58	6·86
160 m. (520ft.)	5·71	6·99
Wind pressure	6·34	7·94
Shearing stress according to the stresses being of the same or of different kinds	3·81 to 3·17	4·44 to 3·49

All in tons per square inch.

International Railway Congress, 1900.

The Congress again in 1900 discussed the question of metallic bridges for railways. It was agreed that the steel to be used should have an ultimate tensile strength of at least 25·40 tons per square inch, with an elongation of about 25 per cent. for all bridges of moderate span, but that for exceptional spans a harder metal should be used. For ordinary bridge work it was decided to adopt the limits of working stress of from 3·81 tons per square inch to 5·71 tons per square inch, and for exceptionally large main girders limits between 5·08 tons per square inch and 7·62 tons per square inch, with about one-eighth more for wind pressure. It was found to be desirable in all cases that the working stresses should never exceed one-half the limit of elasticity of the metal used, and where pieces are subjected to alternating stresses the limit should be still further reduced.

The following formulæ are given in the report, but are not advocated for use:—

$$S = S_1\left(1 + \tfrac{1}{2}\frac{f \text{ min.}}{f \text{ max.}}\right) \text{ according to the stresses}$$

$$S = S_1\left(1 - \tfrac{1}{2}\frac{f \text{ min.}}{f \text{ max.}}\right) f \text{ acting in the same or in opposite senses,}$$

where f min. f max. are the stresses in absolute value, S the limit of working stress, S_1 a certain initial limit of working stress.

Stone.—Mr. Stone makes the statement that a rolling load passing over a railway bridge at full speed produces a far greater deflection than would be the case with the same load at rest. This effect is said to be caused by the sudden and violent manner in which the load is applied, which is accompanied by a general jarring and vibration, specially in the smaller and lighter members. This effect is termed the *immediate* effect. It is also shown that many repetitions of stress, as shown in the experiments of Wohler, Bauschinger, and others, add another effect to the immediate effect, and this is called the *cumulative* effect. Mr. Stone gives an analysis of about 1500 deflections, ascertained in India during ten years, 1882—1892, and finds that the immediate effect of the moving load, compared with that of the fixed load, varies from 100 per cent. for all fixed load to 147·40 per cent. when the fixed load is 2·5 per cent. and the moving load 97·5 per cent. of the total load, or with intermediate values—

Ratio per cent. Fixed load.	Moving load.	Immediate effect of moving load compared with that of fixed load.
0	100	147·40
25	75	110·27
50	50	103·87
75	25	101·21
100	0	100

The cumulative effects of the moving load are thus given by Gerber's parabola:—

Ratio per cent. Fixed load.	Moving load.	Immediate effect of moving load compared with that of fixed load.
0	100	150·00
25	75	140·05
50	50	130·81
75	25	122·96
100	0	116·67

or, by Launhardt's formula,

0	100	150·00
25	75	144·44
50	50	140·00
75	25	136·36
100	0	133·33

But the total effect which the bridge should be designed to bear is the ultimate cumulative effect of the immediate effect, and the total effect of moving load is given as—

Ratio per cent. Fixed load.	Moving load.	Immediate effect of moving load compared with that of fixed load.
0	100	220·31
25	75	157·44
50	50	140·90
75	25	131·28
100	0	125·00

Under these considerations each ton of moving load is assumed to have a *constant* relative value as compared with a ton of fixed load, becoming relatively greater as the proportion of moving load becomes higher, the proper coefficients due to different conditions of loading being as follows:—

Moving load.	Fixed load.	Actual coefficient.
10	90	1·27
50	50	1·41
90	10	1·81

The following rule has been adopted by the Government of India:—"For any member of a railway bridge of wrought iron or steel the total working load is to be taken as the greatest moving load multiplied by a coefficient and added to the actual fixed load. The coefficient to be used for this purpose is 2·0 in all cases, except for the upper and lower booms of triangulated girders, for which a coefficient of 1·5 may be used."

The rule proposed by Mr. Stone is as follows:—"The safe working stress for any member of a bridge truss is to be calculated by the following formulæ:—

$$\left.\begin{matrix}\text{Wrought iron} = 7 - (4 \times R^2)\\ \text{Steel} = 9 - (5 \times R^2)\end{matrix}\right\} \text{tons per square inch}$$

$$R = \frac{\text{range of stress}}{\text{total stress}}.$$

There appears to be little difference between the "immediate effect" and the "cumulative effect" of Mr. Stone, and the "impact and fatigue" of other writers. If it be assumed that for any compound load the variation in the breaking-stress per unit of area depends on the range of stress; or, in other words, the relative amount of the moving load in the compound total load, then for stresses all in the same direction

$$\text{Range of stress} = \text{moving load} = \text{max. B} - \text{min. B},$$

$$\text{and let R} = \frac{\text{moving load}}{\text{moving load} + \text{static load}} = \frac{\text{range}}{\text{total}}.$$

The symbol used for $\frac{\text{min. B}}{\text{max. B}}$ is generally ϕ, and it will be noted that R is the complement of this, or

$$R + \phi = 1,\ R = 1 - \phi,\ \phi = 1 - R,$$

and it is easy to translate an expression from one system to another.

Compression and buckling stresses.—It is, of course, to be understood that for all members subject to compression the areas obtained by the preceding formulæ are to be increased as may be necessary by the use of the ordinary formulæ for compression and buckling stresses.

Examples of the Limits Actually Adopted in the Case of Important Bridges.

The following are given in the tables attached to the report of the Railway Congress, 1900:—

	Tons per square inch. Wrought iron.	Steel.
Forth Bridge—		
Generally	—	7·49
For wind	—	8·51
Bridge over Mississippi, New Orleans—		
For dead load	—	8·89
Live load	—	5·33
Including wind pressure	—	11·11
Niagara Bridge, arch—		
For arch chords {live load... ... / dead load ...	—	5·33 / 10·66
For web of arch {live load ... ... / dead load and temperature	—	4·44 / 8·89
Viaduct over Mississippi at Memphis—		
Tension	—	7·33
Compression	—	6·25
Viaur Viaduct—		
Main girders	5·39	7·30
Cross girders, longitudinals and rail bearers	2·49	4·76
Lattice bars subject to alternate stress	2·54	3·81
Bridge over Colorado at Red Rock—		
Tension	—	6·92
Bridge over Danube near Cernavoda—		
Effect of vertical loads	—	6·35
With wind pressure	—	7·62
Cross girders and rail bearers ...	—	5·08
Rivets	—	4·44
Viaduct across Wupper Valley near Mungoten—		
Cross girders and rail bearers ...	—	4·44
Other parts of the structure ...	—	5·39
Wind pressure...	—	7·93
Bridge over Ohio, Louisville—		
Tension	—	6·92
Bridge over Ohio, Cincinnati—		
Tension	—	7·14
Garabit Viaduct, near Saint-Flour—		
Chords, including wind pressure...	3·97	—
Intrados	4·11	—
and extrados ... ... (including effect of expansion)	4·50	—
All members generally, except above	3·81	—
Viaduct over Hudson River, Poughkeepsie—		
Including wind pressure	—	7·52
Bridge over North-West Canal, Levensau—	$5{\cdot}08\left(1 + \frac{1}{2}\frac{f \text{ min.}}{f \text{ max.}}\right)$	
Rail bearers	3·81	—
Cross girders	4·13	—
Viaduct over Douro, near Oporto—		
Including effect of wind pressure but neglecting rivet holes ...	3·94	—
Bridge over Mississippi, Saint Louis...	4·44	13·33
Bridge over Ohio, near Cairo—		
Top chords, compression	—	6·24
Bottom chords, tension	—	5·80
Marchant's Bridge, St. Louis—		
Compressed top chord	—	6·25
Bottom chord	—	5·80
Bridge over North-East Canal, Gunenthal—		
Dead load...	6·35	—
For live load, depending on the position of the piece in the structure	3·81 / 4·13 / 4·76	— / — / —
Bridge over Lek, Knilenbourg	4·44	6·35
Bridge over Missouri, Sioux City—		
Tension	—	6·92
Viaduct over Adda, Paderno—		
Chords	3·81	—
Lattice bars	3·17	—
Wind bracing	2·67	—

* No. III. appeared December 4th.

	Tons per square inch. Wrought iron.	Steel.
Bridge over Jenisei, near Krasnojarsk	—	4·12 to 4·92
With wind	—	6·03
Britannia Bridge	5·98	—
Viaduct over Niagara, Michigan Central Railway	4·46	6·69
Bridge over Borcea, Fetesti—		
Vertical loads	—	6·35
Allowing for wind pressure	—	7·62
Cross girders and rail bearers	—	5·08
Rivets	—	4·44
Bridge over Missouri, Bellefontaine—		
Dead load	—	8·92
Live load	—	4·46
Bridge over Wahal, Nymegen	4·44	—
Bridge over the Vistula, Dirschau	6·35	7·62
Bridge over St. Lawrence, Cornwall, Ontario—		
Tension	—	5·08
Conway Tubular Bridge	6·19	—
Bridge over Wahal, Bourmel	4·44	6·35
Viaduct over Frisana Gorge	4·94	—
Bridge over Ob, Krivoolitchokova	5·15 / 5·80	—

The following are from other sources:—

Albert Bridge, Brisbane—		
Booms in compression	—	6·5
Booms in tension	—	7
Vertical struts	—	5
Diagonal ties	—	6·5
Wind bracing	—	8
Cross girders and rail bearers	—	6·5
Runcorn Bridge	3·94	—
Dufferin Bridge, over Ganges at Benares—		
Bottom booms and diagonals	—	6·5
Top booms	—	6
Verticals and long unsupported struts	—	5
Hooghly Jubilee Bridge	—	6·5
North-west Argentine Railway Bridge	—	3·81
Bridge over Danube at Cernavoda—		
Allowing 20 per cent. for wind pressure in addition to the dead and live loads	—	7·5
Brooklyn Elevated Railway Bridge—		
In longitudinals	—	4·02
Transverse	—	4·46
Bridge over Danube at Cernavoda	—	6·26
For load and wind pressure combined	—	7·64

The bending stresses in some of the long members arising from their own weight amounts to 1·2 tons per square inch in the diagonals, and to 1·22 tons per square inch in the flanges, and these have been taken into account in determining the sectional area.

	Tons per square inch. Wrought iron.	Steel.
New York Elevated Railroad Bridges—		
Flanges	—	3·6
Web bracing	—	3·4
Members subjected to alternating stresses	—	2
Northern Railway of France, Bridges—		
Main girders	—	4·76
Transverse girders	—	3·17
Rail bearers	—	2·54
Bridge carrying Girdle Railway over Durcq Canal at Paris—		
Lattice girders	3·17	—
Morawa Bridge, Servia (failed)	—	4·42
Nebraska River Bridge—		
Tension	—	5·8
Compression	—	6·25
Atbara Bridge—		
Tension	—	6·69 to 7·59
Compression	—	8·48 to 9·37
Monongahela River Bridge, Pittsburg—		
Compression	3·57	4·37 to 5·89
Tension	4·02	6·70
River Belaya, Samara Railway, Russia—		
Tension	5·7	—
St. John's River Cantilever Bridge—		
Tension and compression	—	4·46 to 6·25
Floor beam flanges, tension and compression	—	5·35
Thames River, Connecticut, U.S.A.—		
All tension	$4·46\left(1+\frac{\text{min.}}{\text{max.}}\right)$	—
Alternate tension and compression	$4·46\left(1+\frac{\text{min.}}{2\text{ max.}}\right)$	—
Plate girders	—	4·46
Malleco Viaduct, Chili—		
Wind and load	—	6·35
Ohio, Bridge on Cincinnati Elevated Railway—		
Tension in eye bars of lower chord	—	7·14
Tension in central braces	—	5·80
Booms of main truss	—	6·25
The Pecos Viaduct, Texas, U.S.A.—		
Tension in long verticals and counter web members	—	4·29
Tension in main web members and lower chords (eye bars)	—	5·36
Tension in main web members and lower chords (plates or shapes)	—	4·29
Tension in lateral bracing	—	6·70
Shearing across fibres	—	4·02
Extreme fibre stress in pins from bending	—	8·04
Compression lengths less than forty radii of gyration	—	4·29
Bearing pressure on surface of pins	—	6·43

AT a Board of Trade inquiry recently held at Preston respecting the explosion of a boiler, on September 18th, at the County Mews, Church-street, kept by Robert Hothersall, it was alleged that the boiler, which was used for driving a grinding and cutting machine, had apparently never been examined for seventeen years. Mr. Hothersall had entrusted the management of it to a horsekeeper, with general instructions to have anything required done. Judgment was given that the explosion was caused by the serious neglect of Mr. Hothersall in failing to have the boiler examined by a competent person, and he was ordered to pay £25 towards the costs of the inquiry.

OUR MINERAL STATISTICS.

AT a somewhat late period of the year the mineral statistics of the United Kingdom have been issued by the publishers. At an earlier date we referred to the general figures, and now propose to amplify our previous remarks by more detailed reference to one or two points which suggest themselves as of interest. To commence with tungsten or wolfram, it is somewhat disappointing to find that the recent spurt made by Cornwall in the output of the ore has not been maintained, and this in spite of the increased demand for and augmented price of the metal. Examination of the return since 1873 certainly shows great fluctuations in the output; thus the 374 tons in 1885 had fallen to 22 tons in 1893, and to nil in 1894 and 1895. This, no doubt, was largely attributable to the decreased use of the salt, tungstate of soda, in the textile industries. Since then, however, the demand for the metal in steel-making has largely increased, and we find that in 1898 Cornwall produced 326½ tons. It is somewhat surprising then to find the figure for 1902 put at 9 tons only, and this from one concern, the East Pool Mining Company. Evidently it does not pay to work the mineral in face of the foreign competition that has arisen, because, as we have said, the demand has largely increased, and with the Government specifications compelling the use of tungsten steel in certain work, it would seem as if its utility were established, and therefore the demand should be likely to prove regular. A good deal was heard about molybdenum steel not so long ago, but we understand that for the present at all events this is defunct, tungsten having entirely displaced it in the market, a somewhat unfortunate matter for those who opened out molybdenum property, and are now unable to sell their product. There is plenty of tungsten in Cornwall, but the method of separating it from the associated tin is in many cases rather beyond the power of those concerned. If this matter was taken up more energetically Cornwall would doubtless be in a position to compete successfully with North-Western Spain, which has the honour at present of supplying practically all the ore for the Battersea Smelting Works.

Turning now to arsenic, the record for 1902 cannot be considered brilliant. The decline in the output of white arsenic was, of course, adumbrated in the preceding year, when the discovery and working of arsenical ores in various parts of the world began to have an adverse effect upon the Cornish industry. Whether the home industry can go on competing with imports from abroad is a somewhat moot point; anyhow there are those who declaim against present Cornish methods or conditions, and say that if certain alterations were effected a profit would be made even at the present low market price of white arsenic, viz., about £13 to £14 per ton. However, we are not discussing practical details, but merely drawing attention to the existing state of affairs, which seem to point to a further decrease in the output of arsenic for 1903. The breaking up of the celebrated Devon Great Consols Arsenic Works after its long existence as the premier arsenic mine of the world, has a somewhat melancholy interest for those concerned in our south-western mining, though it seems to have been unavoidable in face of the competition which has arisen in quite recent years. The Devon Great Consols, it should be remembered, worked arsenical pyrites alone, and did not manufacture white arsenic merely as a by-product in tin and copper mining. It is from the latter source that Cornwall will probably still continue to supply the material. The output of arsenical pyrites, or mundic, as the Cornish miners term it, sunk from 2578 tons in 1901 to 829 tons in 1902, while the white arsenic fell from 3361 tons in 1901 to 2131 tons in 1902, not such a great fall as to indicate speedy extinction of the business. Arsenical ores have been discovered in great abundance in Spain and Portugal, regular shipment now being made to Swansea and Runcorn. The projected developments of arsenic mining in North-Western Spain have not come to much, but at Ribas, in the Pyrenees, above Barcelona, a new mining company promises to produce largely works capable of an output of 15 tons per day being almost completed at Badalona. Australia and Canada have also become producers and exporters of arsenic, and so unless the demand increases materially, which there is no reason to suppose will be the case, we cannot help predicting a still further decline in prices in the near future. Turning to cobalt and nickel, the production, as in recent years, was nil, and it is noticeable that the spurt in uranium mining, as carried on at the Grampound-road mine, Cornwall, was not maintained, the output falling from 79 to 52 tons. The report says that copper mining is rapidly decreasing in importance in Britain. Of course, looking at the production for 1863, when copper ore and precipitate amounted to 210,000 tons, this is certainly the case; still the output of Cornwall and Devon for 1902 amounted to the respectable figure of 4897 tons, only 202 tons below that of the preceding year. Moreover, there is reason to suppose that we shall see an increase rather than a further decrease before long, what with the application of the Elmore oil recovery process to low grade material, and from the opening up of new ground, which promises to be highly productive, in the neighbourhood of St. Austell. We speak with some reserve with regard to this prospective increase, but we have good reason for supposing that the moribund copper industry of Cornwall will take a new lease of life, as the result of the application of more economical methods of working, which have justified their adoption in other localities. With regard to tin, which is, of course, the mainstay of Cornish mining, it is not easy to speak with any degree of confidence as to the future, though it is encouraging to note that the output in 1902 was higher than in the last six years, though it did not reach the monetary value of 1900. The agitation against the payment of Lords' dues out of all proportion to the profits realised tends to become more acute, and it is much to be wished for the stability of the industry that more amicable arrangements could be arrived at between the parties to the conflict. With regard to lead, a continued decrease in production has to be recorded, though not to a very serious extent. Respecting the abandonment of the Teesdale mines, in Durham, so long worked by the London Lead Company, we may mention that some of the property has been acquired by a new company, and with the aid of more modern plant there seems every reason to predict for them a successful career; certainly recent development work has quite negatived the idea that the property is worked out. The traditions of Derbyshire as a lead mining centre form matter for treatment by the historian rather than by the present-day commentator; still the activity of the Bradwell of past years is reflected to a considerable extent in Darley Dale to-day, where the Mill Close mine had an output last year of about 3000 tons of ore. The complex sulphide question has not attained such prominence in Great Britain as has been the case at Broken Hill, but still there are properties, notably in Wales, which contain plenty of mineral in the form of mixed lead, zinc, and copper sulphides, which only await a satisfactory method of treatment to become undoubted paying concerns. Apart from the complex ore mines, the production of blende in Wales, Derbyshire, and at the Cumberland mines of the Vieille Montague Company, shows a decided increase over that of last year, the figure of 25,000 tons being the highest reached since 1888. In view of the rich deposits of manganese which are found in abundance in so many countries, it is not surprising that a further falling off is seen in the British production, and there does not seem much prospect for this branch of mining. The iron ore output of 13½ million tons is higher than in the preceding year, though not quite up to the three years before, and recent discoveries in Cumberland and Furness show that we shall continue to obtain the major part of our requirements of iron ore from our own country. It seems that some little time must elapse before British producers experience the much talked of competition from Norway, though against this it appears probable that the falling off of shipments from Northern Spain is likely in the near future to be more than made up from the new mines of high grade ore now being opened up in Southern Spain. Referring to the alkaline earths, it is matter for interest to note that the output of celestine, or sulphate of strontium, in Gloucestershire and Somersetshire amounted last year to 32,281 tons, which is double the figure for the preceding year, and also considerably above the yield in any year since 1884, when our statistics for this mineral commence. To the best of our knowledge, this material finds practically its only employment in the pyrotechnic manufacture, in Great Britain at all events, though it has long been used in connection with the refining of sugar in some localities. The figures for barytes are not so encouraging, though the mineral is more widely distributed in the British Isles. The applications of barytes are much more numerous than is the case with sulphate of strontium, and the British output of 23,000 tons is largely augmented by imports from abroad. In conclusion, the Blue-book contains much matter that might be referred to at length, but space prevents more than passing reference to a few topics, and in this brief review of an interesting annual publication we have sought to restrict our notice to topics which are not only of special interest to individuals, but which show the trend of different branches of our mining industry. A close perusal of the volume cannot, we think, fail to convince the pessimist that our metal mining industry is by no means in the utterly forlorn condition in which it has oft been represented.

TREVITHICK'S LOCOMOTIVE EXPERIMENT IN 1808.

IN Mr. Francis Trevithick's life of his father, the celebrated Richard Trevithick, he gives an account of the trial of a locomotive in the year 1808, near the New-road, as it was then called. It is a matter of regret that the notices of this early trial are meagre and vague, and we are glad to be able to supplement the information given by Mr. Trevithick at pages 192-197 of his first volume by means of extracts from the advertising columns of the newspapers of the day.

The first advertisement relating to the trial appeared in the *Times* of July 8th, 1808, and is as follows:—

"We are credibly informed that there is a steam engine now preparing to run against any mare, horse or gelding that may be produced at the next October meeting at Newmarket; the wagers at present are stated to be £10,000; the engine is the favourite. The extraordinary effects of mechanical powers is already known to the world; but the novelty, singularity, and powerful application against time and speed has created admiration in the minds of every scientifical man. Trevithick, the proprietor and patentee of this engine, has been applied to by several distinguished personages to exhibit this engine to the public, previous to its being sent to Newmarket. We have not heard this gentleman's determination yet; the greatest speed will be 20 miles in one hour, and its slowest rate will never be less than 15 miles."

On the 12th of the same month this advertisement appeared:—

"*Times*, July 13, 1808.

"The steam engine mentioned in our paper of Friday last, to run at Newmarket next October meeting, will be completed this week, and exhibited to the public in the fields adjoining the Bedford Nursery, near Tottenham-court-road, of which due notice will be given in this paper."

The matter is referred to in *Johnson's Sunday Monitor* and in the *Observer* of July 17th:—

"The most astonishing machine ever invented is a steam engine with four wheels so constructed that she will with ease, and without any other aid, gallop from 15 to 20 miles an hour on any circle. She weighs 8 tons, and is matched for the next Newmarket meeting against three horses to run 24 hours, starting the same time. She is now in training on Lady Southampton's Estate adjoining the New-road, near Bedford Nursery, St. Pancras. We understand that she will be exposed for public inspection on Tuesday next [*i.e.*, July 19th]."

The mention of the Bedford Nursery enables us to localise with considerable exactitude the place where the experiment was made, as the contemporary maps and plans show the Nursery as occupying the site of Euston-square. It is a curious coincidence that, thirty years afterwards, this spot should have been fixed upon as the terminus of one of our great railway lines.

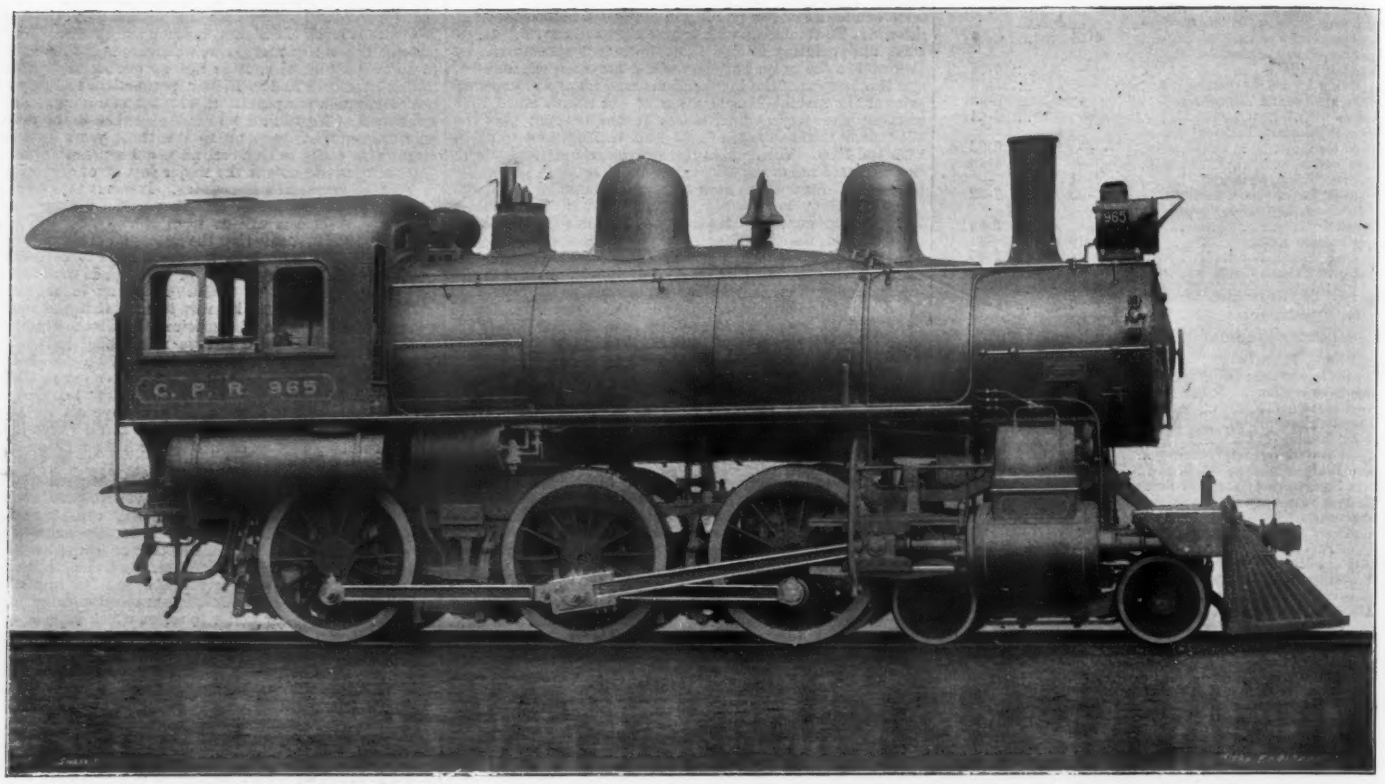
The postponement of the trial was announced in the *Times* of July 20th:—

"RACING STEAM ENGINE.—The public are respectfully informed that the exhibition of this machine, which was to have taken place this day, is unavoidably postponed till Monday next, the ground under the Railway on which it was to run being too soft and spongy, requiring additional support of timber."

In the *Sun* of July 21st we read:—

"The new *trotting match*, in which one of the competitors is to be a *steam engine*, if the issue should be favourable to the latter, may be expected to produce a great change in many of our calculations and in many articles of consumption. We shall know what amount of posting there is upon any road not by dust, but by smoke; instead of half a peck of oats, a sack of coals will probably be a feed for a stage of moderate distance. A coachman, instead of being praised as a good whip, must be rated by his qualities as a stoker; our four-in-hand clubs will be extinct, and those who are now

COMPOUND LOCOMOTIVE, CANADIAN PACIFIC RAILWAY



said to be run out as sportsmen will hereafter be recorded as burnt out! Our turnpike tolls must be calculated not by the number of horses in a carriage, but by the power of its engine. The post horse duty must be exchanged for one upon smoke, and the fastest travelling must be looked for, not in the corn countries, but in the neighbourhood of the greatest coal mines."

Just at this time Trevithick was a witness in an action which was being brought by one Chapman against the Thames Archway Company, of which Trevithick was the engineer, and in the report of the case in the *Sun* of July 25th, it is stated that "he was the inventor of the steam engine which is to run at Newmarket," which shows the event had taken some hold on the public mind.

Writing on July 28th to his friend, Mr. Giddy, Trevithick says: "I have yours of the 24th and intend to put the inscription on the engine which you sent me. About four or five days ago I tried the engine, which worked exceedingly well; but the ground was very soft, and the engine—about eight tons—sank the timber under the rails, and broke a great number of them. I have now taken up the whole of the timber and iron, and have laid balk of from 12in. to 14in. square down on the ground, and have nearly all the road laid again, which now appears very firm. We prove every part as we lay it down, by running the engine over it by hand. I hope it will all be complete by the end of this week. The tunnel is at a stand."—"Life of Trevithick," vol. i. p. 192.

Nothing more is heard of the enterprise until September 18th, when the following paragraph appeared in the *Observer*:—

"Extraordinary wager.—It has been some time announced that the new machine for travelling without horses, being impelled entirely by steam, was matched to run twenty-four hours against any horse in the kingdom. This bet, so novel in the sporting world, will be decided on Wednesday and Thursday next. The machine is to start at two o'clock on Wednesday, on its ground in the fields near Russell-square, to demonstrate the extent of its speed and continuance. It is calculated that the machine, though weighing eight tons, will travel 240 miles at least within the time limited. Very large sums are depending on the result."

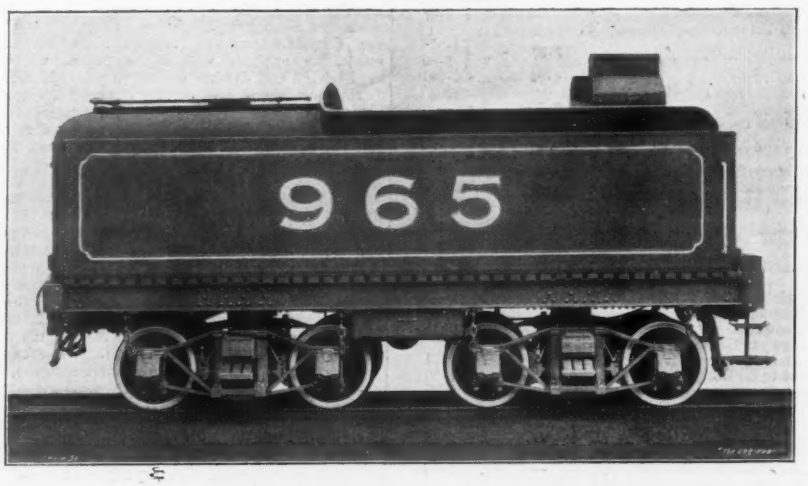
The files of several newspapers of the day have been searched, and experts in the history of horse-racing have been consulted, but without result, so that, in all probability, the race never came off. Beyond Trevithick's letter already quoted, there is no contemporary account of the experiment, the nearest approach being a letter written by a spectator nearly forty years after the event. The writer was John Isaac Hawkins, a well-known inventor and writer on mechanical subjects, who must certainly be regarded as a competent witness. His letter appeared in the *Mechanics' Magazine* for March 27th, 1847, and he stated that he rode on the engine, watch in hand, and that it attained a speed of 12 miles an hour; but, unfortunately, he gives no details of the construction of the engine, and no dimensions. He tells us that the trial was put an end to by an accident, the engine being thrown off the line. Trevithick's stock of ready money was exhausted, and as the shillings charged for admission did not yield enough to pay working expenses, the enterprise was abandoned. What became of the engine is not known.

There is a view in Trevithick's "Life" (vol. i., page 194) of the enclosure in which the circular railway was laid down, but it is wholly imaginary, being due solely to the fancy of the draughtsman. The view is also reproduced in Mr. R. L. Galloway's "Steam Engine and its Inventors."

THE Russian Ministry of Ways of Communication is about to fit up a special laboratory for the purpose of making scientific experiments with various forms of fuel for use on the Russian railways.

COMPOUND LOCOMOTIVES, CANADIAN PACIFIC RAILWAY.

THE Canadian Pacific Railway Company some few months ago, it will be remembered, in addition to placing contracts for a considerable number of compound locomotives with the North British Locomotive Company, of Glasgow, also ordered twenty compound locomotives from the Saxon Engine Works at Chemnitz—Sachsische Maschinenfabrik, vorm R. Hartmann—one of the best-known locomotive engineering firms in the German Empire. These locomotives are, we believe, the first ever built in Germany for a North American railway. They have been erected strictly to Canadian practice, from the designs of Mr. E. A. Williams, the superintendent of motive power, and Mr. A. W. Horsey, the chief draughtsman, of the Canadian Pacific Railway. They have six-coupled, 5ft. 3in. wheels, whilst the wheels of the leading bogie have a diameter of 2ft. 6in., and the tender wheels are 2ft. 10in. in diameter. The cylinders are 22in. by 26in., and the steam pressure 210lb. per square inch. The boiler is of the extended wagon-top type, with radial stays to the fire-box and a sloping front sheet. The boiler, the inside fire-box, and the tank plates are all constructed of the best mild steel; the tubes are of weldless Swedish charcoal mild steel, whilst cast and nickel steel, supplied by Fried Krupp, are largely employed in the constructional details. The heating surface is as follows:—Fire-box, 152·6 square feet; tubes, 2262·9 square feet; total, 2415·5 square feet. The grate area is 33·1 square feet. The valve gear is Stephenson's. The tender, which will be seen from the accompanying illustration, is of the standard hopper type of the Canadian Pacific Railway, and has a capacity of 5000 imperial gallons, and space for 10 tons of bituminous coal. The electric lighting dynamo, placed just in front of the cab and driven by a steam turbine, supplies current for an installation of incandescent lamps, placed along the running boards, over the motion, and in the cab, in addition to a powerful Edwards headlight. The engines are equipped with the Westinghouse-American combined air brake, and a complete air signal equipment, as also the Gold system of steam heating. The engines, several of which have already been completed and delivered at Montreal, will be subjected to exhaustive comparative tests with the engines which have been delivered by the North British Locomotive Company, of Glasgow, the result of which will be watched with no little interest. One of these engines is illustrated above.



TENDER FOR CANADIAN PACIFIC RAILWAY

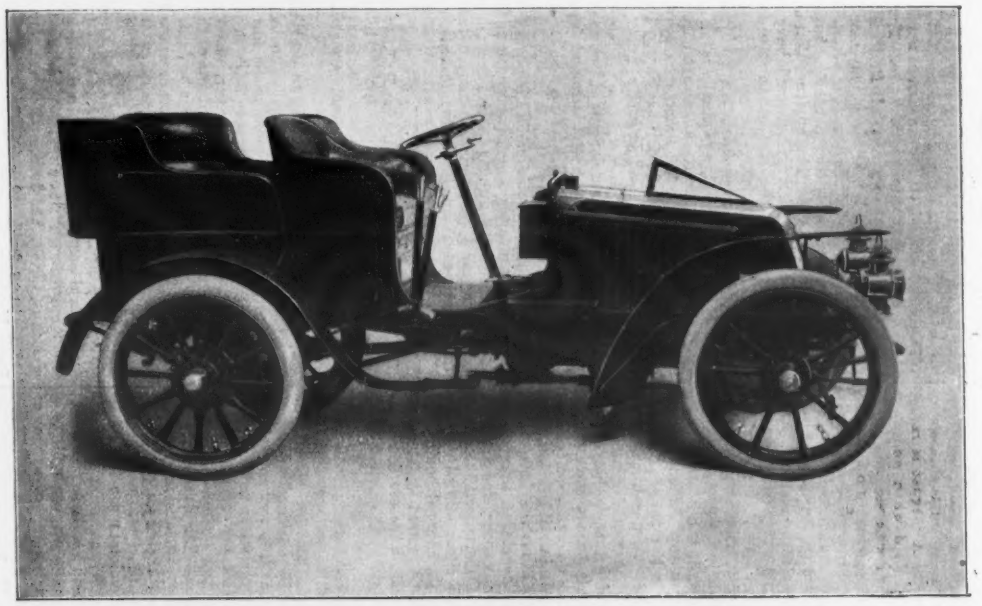
THE PROGRESS OF THE SIMPLON TUNNEL.

THE unusual and unforeseen difficulties that have been encountered in driving the Simplon Tunnel have for some time past made it apparent that the completion of the work at the date originally fixed was not to be expected, and this has led to a modification of the arrangement between the contractors, Messrs. Brandt, Brandon and Co., and the Jura Simplon Railway Company, which received the sanction of the Swiss Federal Council in October, 1903. According to this supplemental contract, the date for the completion of the full-sized single line tunnel No. 1 and the bottom drift of No. 2 is postponed to April 30th, 1905, with a premium of £80 per day for every day saved in the full-size tunnel, and a corresponding penalty for every day in arrear. A period of two years from that date will be allowed to the contractors to decide whether they will undertake the completion of the second tunnel, and in the event of their agreeing to do so, a period of four years, counting from the date of the contract, is allowed for the completion of the work. By this arrangement the cost of the two tunnels will be increased from the original estimate of £2,780,000 to £3,120,000.

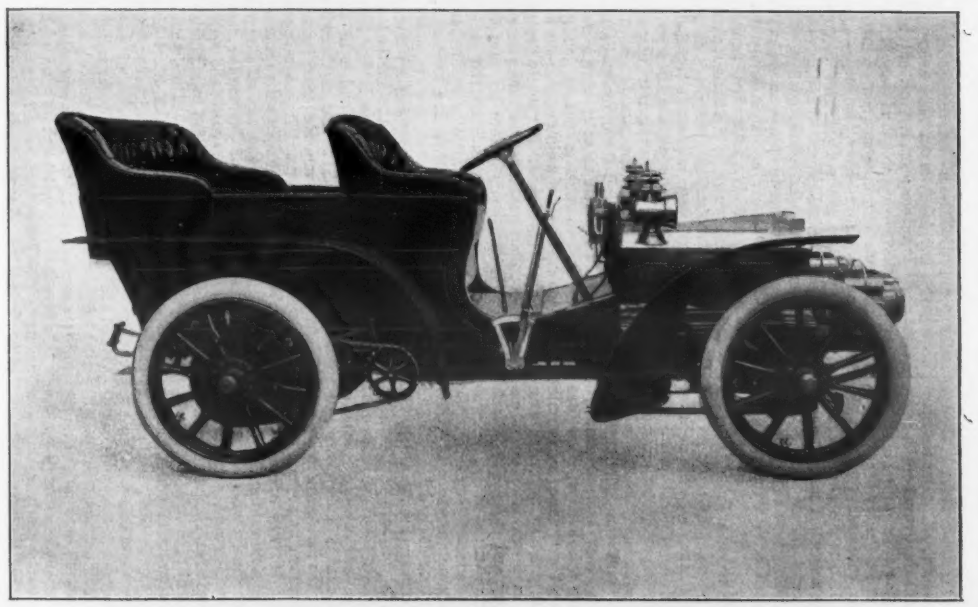
As regards the present state of the works, the lengths driven at the end of September, 1903, were 9950 metres (6·28 miles) on the north side, and 7275 metres (4·52 miles) on the south side, leaving in round numbers 1¼ miles of solid ground to be holed through. The average rate of driving during September, 1903, has been 5·46 metres (17ft. 11in.) per working day on the north side, and 5·57 metres (18ft. 3in.) on the south side. The working force amounted to 3300 hands, out of which number 2300 men were employed in the tunnel. The volume of water discharged from the tunnel

MOTOR CARS AT THE PARIS SHOW

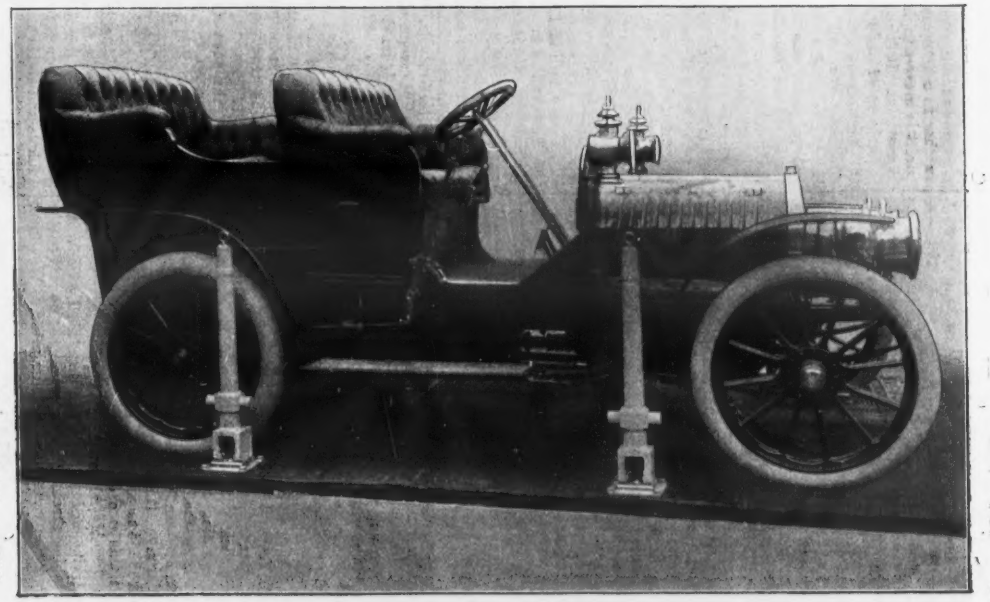
(*For description see page* 593)



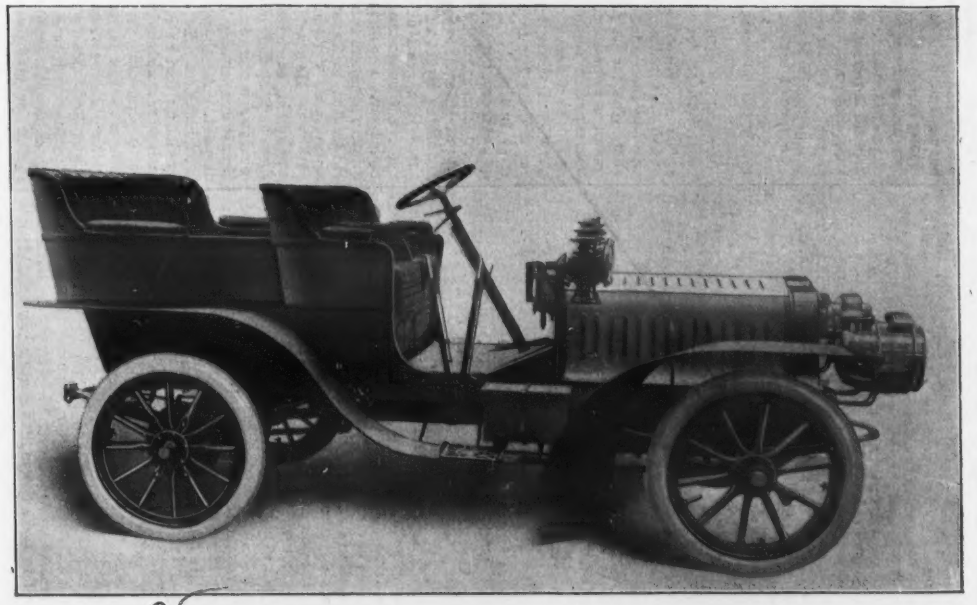
THE RENAULT CAR



THE PEUGEOT CAR



THE HOTCHKISS CAR



THE CLEMENT CAR

mouth on the south side, which amounted to 1200 litres per second (15,800 gallons per minute) in 1902, has diminished in the present year (1903) to 924 litres (12,000 gallons) per minute.

From the quarterly return ending June 30th, 1903, the temperature conditions were as follows:—The maximum observed temperature of the rock in bore-holes on the north face was 127 deg. Fah., and in the drift on the same side, at a point five miles from its mouth, 75 deg. Fah., and on the south side, 3¾ miles in, 69·8 deg. Fah. The mean temperatures in the working ends were, however, considerably higher, rising during periods of loading broken stuff, which is always the hottest part of the work, to 90 and 91 deg. Fah. on the north side, and 85 and 87 deg. Fah. on the south.

The ventilating arrangements on the north side provide a supply of fresh air under pressure amounting to nearly 90 million cubic feet in twenty-four hours. This, in passing through the lateral intake drift to the point of entry into the main tunnel, is raised in temperature from 54 deg. to 83 deg. Fah. From the latter point it is delivered to the working face by water jet injectors, which cool it down to about 68 deg. The air in the drift is further cooled by water sprays and a continuous flow of water over side walls. On the southern side, where the increase of temperature has not been so great, special cooling arrangements for the air have not as yet been required.

LITERATURE.

Conduction of Electricity through Gases. By J. J. THOMSON. Cambridge: University Press. 1903.

(FIRST NOTICE.)

THIS book is written backwards, which may be an advantage, though we doubt it. The simple and direct way of writing a book about a new theory or hypothesis, such as that of corpuscles, would be to begin by explaining, in as clear a manner as possible, the author's ideas as to what a corpuscle is. When the reader has been given a clear grasp of the notion, the author would go on to describe all the phenomena that throw light on the subject, and would explain or even foretell each of them in the light of his theory. This would be instructive, but wanting in dramatic interest, and so Professor Thomson has chosen the method of fiction of the detective novel. The detective novel always begins with a tangled mass of startling facts which appear to have no connection with one another. The first two chapters thus give an account of experiments on the conductivity of gases. The detective novel then usually goes on to give the detective's theory. The theory is always very plausible, but in the last chapter it is proved to be completely wrong. Professor Thomson devotes the next two chapters to detective theory. It is more mathematical than usual in light fiction, but is otherwise according to the rules of composition. We cannot tell whether the theory will be completely upset in the last chapter, because the last chapter has not been written. Perhaps it never will be written. The author not only writes the whole book as a detective story; but he adopts the same method of construction in the different parts, so that it is to some extent detective stories within a detective story, each branch of the subject beginning with an account of apparently inexplicable phenomena, and ending with their being brought into line, and explained in terms of corpuscles.

It may be asked why a book of this nature, dealing with the most advanced branch of physical science, in a style intended only for specialists, is reviewed in a technical paper.

The object of a review is generally to show how much better the reviewer could have written the book, or, at any rate, how clever he is; but incidentally this review will try to give the reader enough idea of the book and the subject treated in it for him to judge whether he should read it himself.

It will be remembered that in the other great detective story the reward for finding the white elephant was only for the detectives; no one else's work could be recognised. It is the same in unapplied science; an outsider who did or knew anything would come into conflict with the force. Then why should engineers trouble themselves about corpuscles and ether? Because it is our business to understand the fundamental laws of Nature, and to know the underlying principles of the use of the forms of matter with which we work. Here we have an account, nominally of phenomena connected with gases, but really of what appears to be a working hypothesis considerably farther reaching than the atomic theory. We have an account written by a specialist who is head and shoulders beyond any one else in this line, as he is a first-rate mathematician and co-ordinator of facts, and at the same time a first-rate finder of facts and organiser of experimental work. Heaviside remarked that we could not expect Faraday to have been a mathematician; that would be too much, as he was such a great experimenter. In science the co-ordination of facts is achieved by men who do little or no experiment. Ampère, Boltzmann, Fourier, Fitzgerald, Gauss, Gibbs, Heaviside, Helmholtz, Kelvin, Kirchhoff, Lagrange, Laplace, Larmor, Lorentz, MacCullagh, Maxwell, Newton, Ohm, Rankine, Stokes, Weber, and Young—to take a medley—have hardly anything experimental connected with their names; co-ordination is their work. But Professor Thomson is not only a mathematical co-ordinator—all co-ordinators must be essentially mathematical—but he is an experimenter himself, and apparently an organiser of an army of experimenters. Throughout the book we find experiment after experiment credited to people so far unknown to fame, except perhaps in this one connection, as if the author were merely its humble chronicler; but most of them hail from Cambridge, and there is the same kind of devilish cunning running through the experiments; so it is pretty clear who is the controlling master mind. We have, therefore, in this book, a mixture of experiment and theory, written by a specialist of the first rank, dealing with the most important scientific question of the day, and except as to the method of exposition, putting the matter as clearly as its nature admits. The best thing for us to do is to read the book and understand as much as we can. The author is a mathematician, not a mathematiculist, so his mathematics are as simple as cases allow, but he is difficult to follow. It is not necessary, though it may be advisable, to understand it all. But the engineer may well say, "What a fearful dust-cloud of electrons, corpuscles, and ions these people have raised! I will wait till it settles, and then I will clean my eyes out and look about me." It must be confessed this was the present reviewer's attitude. Life is too short, and he was happy in forgotten electromagnetics and complete ignorance of corpuscles till the editor broke in upon him by demanding a review. The review will thus give rather the impression of an outsider than the judgment of a specialist.

In dealing with the ultimate constitution of things in general there are several logical pitfalls which are specially dangerous. There is doubtful ontology; or how far are matters that are inconceivable, because outside our experience or possible experience, knowable at all? How far are experiences of molar phenomena true guides as to molecular matters? If the inhabitants of one universe cannot, or think they cannot, conceive action at a distance or infinite sub-division, does that show that there is no action at a distance or infinite sub-division? Is there not generally a major premiss missing? Next there is inextricable confusion as to theory, hypothesis, analogy, and statement of fact. We do not in the least know whether the author believes corpuscles exist in fact, or puts their existence forward as a working hypothesis, a theory, or an analogy. Then there is a great difficulty in thought and language in avoiding a confusion of idea between the molar and the molecular. For instance, a man who was then writing numerous papers came to us puzzled about gas molecules. He wanted to know how molecules rattling about at a given speed were affected by change of their own temperature. He considered taking the molecules one by one and heating them red hot in a Bunsen flame, and putting them back at their old speeds. He was uneasy in his mind; but writers on molecules fall into similar confusions almost unavoidably and unconsciously, with no mental disquiet. Another fallacy is the idea that pulverisation is explanation. To explain Professor Thomson's genius by stating that he is composed of molecular professors, each with a certain genius per element of volume would be the conventional scientific explanation, his genius being a volume integral. If there were such a thing as jealousy among men of unapplied science, a detractor might apply Stokes's theorem, and urge that instead of regarding him as a genius through and through, his genius may be reckoned as a quantity entirely on the surface, or may even be considered as lying along a single line. It would be replied that Professor Thomson is not homogeneous. Perhaps not; we do not know him, but is that a conclusive answer? Explanation by pulverisation comes in when we say we all understand masses that fly about and hit one another; we will therefore explain the constitution of masses of matter by saying they are made up of little masses having the familiar properties of big masses and a host of very unfamiliar properties of their own. Looking through telescopes, we find masses going round one another in orbital motion; so we explain the motion of our little masses in the same way. A magnet is rather mysterious. It is completely explained when we say it is made up of little magnets, each with the property of the big magnet and a lot of other queer properties in addition. We will not refer again to questions of epistemology, or of explanation by comminution; they are apt to make one doubtful as to the soundness of all theory of the ultimate constitution of the universe. The molar-molecular confusion is more easily avoided, however, and crops up a good deal.

Professor Thomson begins by recounting how gases conduct electrically under certain conditions, and how the current and pressure are related, and shows that a gas under the influence of Röntgen rays is ionised, and that this ionisation accounts for the facts. The gas molecules are split up by the ionising agents, and the positive ions go one way and the negative the other, giving up their charges to the conductors, so that there is a current. It is like solution electrolysis or the dissociation theory, still in fashion while we write, except that the dissociation is not automatic, but is effected from the outside. Under ordinary conditions the ions diffuse slower than the gases, so it is concluded they collect molecules around them; water vapour, for instance, slows them down considerably. It is next found that the ionic charges correspond with those of hydrogen in solution electrolysis. The ions, like charged bodies, are acted on by a magnetic field. This is used to determine what in this journal would be called the ampère-hours per ton of ions. The ions are shot out of an electric cannon, and their trajectory examined, the field taking the place of gravity, except that the force now depends on the speed of the projectile. The ampère hours per ton of ions is about 770 times that of electrolytic hydrogen. The ionic charge can be measured in various ways. The trajectory of an ion in a vacuum tube is affected by either an electric or magnetic field. Some negative ions, such as radium ions, are investigated in air as they go through atoms and molecules without hitting them. The positive ions are difficult to deal with by the trajectory methods, as they are evidently rather big things, carrying the same sort of charges per ton as in wet electrolysis.

The next problem is to find the charge per individual corpuscle. This is carried out by counting the corpuscles. It is found that if damp gas is suddenly expanded when ionised, each negative corpuscle forms a nucleus and starts a drop. From the rate of settling of the fog the size of the drops is known. Thermodynamics gives the weight of water; hence the number of drops and the number of corpuscles is found. The idea is that the electric attraction overcomes capillarity and allows a drop to form. There appears to be intrusion of molar ideas. One pictures the corpuscle as flying about so vigorously that it goes through a positive ion like a Mauser through a mule, without either noticing, yet it collects neutral molecules of water vapour. Then surely capillarity is an idea belonging to a much larger scale than corpuscles, ions, or single molecules. Once a negative corpuscle had caught on to a neutral water molecule one does not see why the large positive ions should not form drops also, especially as dust does so. The positive ion really begins one step in advance of the negative. Imagine the air moist enough for equilibrium with a flat water surface. Then any drop evaporates. Then let the air be so moist that say a drop of 20 B.W.G.—to use an engineering size—is in (unstable) equilibrium. If a little water condensed the drop would then go on growing; if a little evaporated, it would then give off vapour till the drop disappeared. But if the drop is very slightly electrified, the charge will exercise its action as the drop gets very small, and the drop will only evaporate down to its equilibrium size. This is enormously above atomic size, so one would expect all the drops to be the same size; yet after a fall of cloud there appears to be a set of small drops left ready to nucleate another cloud. Reinold and Rücker, however, show a sinuosity in the surface tension curve which may come in. But surely Professor Thomson ought to explain capillarity in terms of corpuscles and electro-magnetic theory before he can discuss surface tension and vapour tensions on the scale of a single corpuscle. The whole question is further complicated by vapour pressure variations due to chemical action of the ionisers.

The numbering of the corpuscles is the most important step of all. The devising of the method is a stroke of genius. But we have only one bridge thrown over an apparently unspannable abyss, and it in no way shows want of appreciation of the feat of throwing the bridge across, if we urge the importance of testing it in every way possible. At present it is not safe enough for the traffic. We would like an alternative route.

Having got an idea of the size of a corpuscle, and its electric charge, the author devotes the rest of the book to describing phenomena to excite the reader's curiosity, and then showing how they can be explained by studying the little ways of corpuscles. Thus, the ionisation by hot solids is discussed, and the effect of temperature on dissociation and chemical, or, rather, electro-chemical reaction. Except a vague notion of corpuscles being shaken about inside molecular cages and getting shaken out when the agitation is very violent, no idea is given of the author's conception of corpuscles, atoms, molecules, or ether; and throughout the book one has the feeling of violation of scale. For instance, what is the author's mental picture when he talks of corpuscles sticking to bits of dust? The disproportion of the lady-bird and elephant in the toy ark is nothing to it. At other times the corpuscles "adhere" to molecules of gas.

Up to half-way through the book we meet Röntgen rays as ionisers, but no idea is given of what Röntgen rays are or how they ionise. Then we find suddenly an idea as to what these rays are, and a promise to explain later on, which shows that the author fully realises that his book would be simpler read backwards. Röntgen rays appear to be electro-magnetic noises, compared with light as electro-magnetic tones. Thus, when the (late, not present) organist of Professor Thomson's college pressed all the keys on one manual with his forearms to give a tedious preacher a hint, he produced the analogue of light, except that he had only twelve degrees to the octave. The applause that decorum prevented the congregation giving would have corresponded to Röntgen rays. The idea is that the corpuscles are very small, each carrying its own charge, and light waves, especially ultra-violet, set up resonance with those of suitable period, and finally shake them out of the molecules. A Röntgen impulse, on the other hand, so increases an already existing velocity of a corpuscle as to fire it out of the molecule at once. The corpuscle itself makes an electro-magnetic noise when it is quickened.

Next we have Becquerel rays. Here the author's art makes the reader feel that the *a* and *b* rays are like "soft" and "hard" Röntgen rays, and he puzzles over this, trying to form an idea how uranium emits electro-magnetic noises continually. He is pleased to find later that Becquerel rays are merely corpuscles fired out, not waves. We cannot discuss radium here; it must be left for the society papers and what a cynic once called the self-advertisement columns of the *Times*.

Engine Tests and Boiler Efficiencies. By J. BUCHETTI, sometime Professor at the Central Technical School, Paris. Translated and edited from the third edition by ALEXANDER RUSSELL, M.I.M.E. Archibald Constable and Co., Limited, Westminster. 1903.

THIS is an excellent translation of an excellent book; so good that no mechanical engineer who has to do with steam or gas engines can consider his library complete without it. We have found very little in it with which to find fault. The title is, however, unsatisfactory, for it conveys no just idea of the contents of the volume.

The first engine tests carried out by James Watt, after him by McNaught, and in Cornwall, where the publication of Lean's Circular put mine captains on their mettle, were comparatively crude affairs. The first really accurate work done in this country, at all events, was that carried out by Messrs. Easton and Amos for the Royal Agricultural Society—a work pushed still further by the late Sir Frederick Bramwell, Mr. Alfred Cowper, Mr. Menelaus, Sir W. Anderson, and others. In the present day yet more elaborate work has been done by Unwin, Perry, Kennedy, Willans, and others, so that at last we find that the testing of engines and boilers has become an elaborate process, highly scientific, and requiring

much skill, mechanical and chemical knowledge, patience, and accuracy for its due performance.

Mons. Buchetti's original work is simply a hand-book. It covers the whole ground. It gives particulars of all the successful apparatus required. It gives instruction for making all the necessary calculations. But it does not give, and no book can give, that special information which can only be obtained by direct instruction from a competent teacher in the engine and boiler-house, and which will alone enable errors to be avoided and difficulties to be overcome—difficulties which no one can realise merely from reading a book. The student will begin to understand their nature when he has to take successive diagrams from the high-pressure cylinder of a fast running marine engine while the ship is rolling heavily; and he can gather further experience if he spends a couple of hours in a stokehold tallying bags of coal.

The volume contains eleven chapters and an appendix. These describe indicators, the study of the diagram, testing gas and oil engines, the measurement of indicated horse-power, the measurement of brake horse-power, the use of a dynamo as a brake, the properties of steam, evaporation, combustion, and steam trials. Within reasonable limits it would be impossible to do justice to the care, detail, and thoroughness with which our author has handled his subjects. There is not in the English language any treatise on testing brakes which is nearly as complete as Mons. Buchetti's chapter. It is illustrated by twenty-eight excellent engravings. We frankly confess that until we saw this book we had no idea that half so many varieties of test brakes existed. We notice that in dealing with the Appold brake used for so many years by the Royal Agricultural Society, Mons. Buchetti says nothing whatever of the controversy which took place among engineers as to the errors introduced by the equalising lever. Apparently he has quite overlooked this error, or else regards it as too trifling to be of any moment.

There are certain matters of detail in the conduct of tests on which we are not quite in accord with the author, but these are relatively unimportant. The practice of engineers who are in the habit of carrying out steam trials will always vary in detail.

The book is well printed and well illustrated, and the translator has done his work very well indeed.

BOOKS RECEIVED.

Foundry Nomenclature: The Moulders' Pocket Dictionary. Compiled by John F. Buchanan. London: E. and F. N. Spon, Limited. New York: Spon and Chamberlain. Price 5s. net.

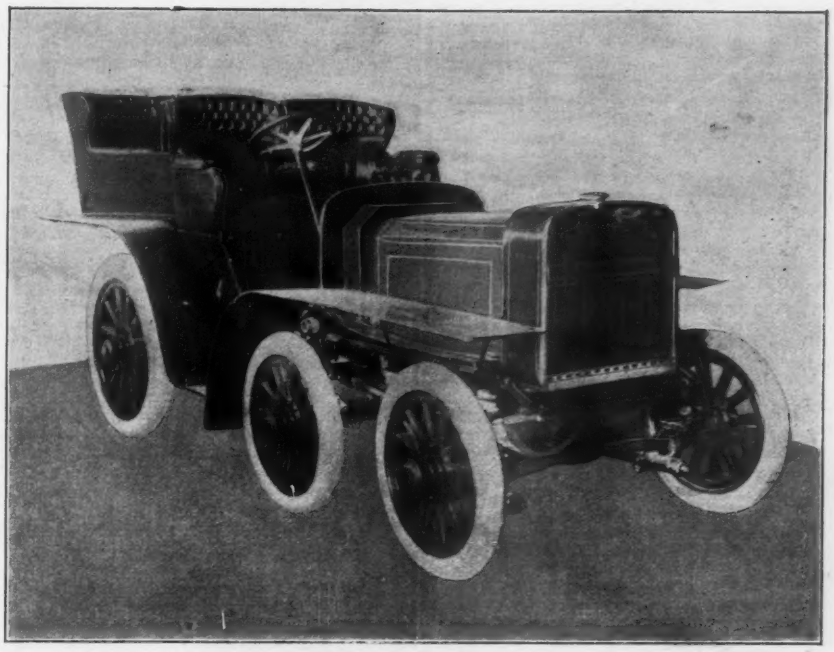
L'Année Technique (1902-1903): *Locomotion et Moyens de Transports, Production et Emploi de la Force Motrice, Travaux Publics et Architecture, Technologie Générale, Astronomie et Cosmographie* Par A. Da Cunha, Ingénieur des Arts et Manufactures, Librairie Gauthier-Villars. Avec Preface de M. Paul Bodin, President de la Société des Ingénieurs Civils de France. Un volume grand in-8 de viii., 303 pages, avec 120 fig. 1903. 3f. 50 c.

THE INSTITUTION OF CIVIL ENGINEERS, GLASGOW ASSOCIATION OF STUDENTS.—The opening meeting of the session of the Glasgow Students' Association of the Institution of Civil Engineers was held last week in the Association's rooms, 207, Bath-street, Glasgow. The president, Mr. J. E. Harrison, delivered his inaugural address in presence of a large attendance of members. Mr. Harrison traced generally the development of our railway system, as it afforded probably the widest field for the employment of the civil engineer, and was one with which the growth of Glasgow had been very closely associated. He briefly reviewed the situation in which railways stand to-day, and dwelt especially on the part which the engineer played in the destiny of such undertakings. He spoke of some of the outstanding principles which ought to guide him in his duties, and gave practical illustrations of the application of the principle of economy with efficiency which ought to be the aim of the engineer. These illustrations related chiefly to steel work design, applied more particularly to railway bridge construction. Mr. Harrison was thanked for his address.

INSTITUTE OF SANITARY ENGINEERS, LIMITED.—On Saturday last a meeting of the members of the Institute of Sanitary Engineers residing in Lancashire and the West Riding of Yorkshire was held at the School of Technology, Sackville-street, Manchester, with the object of forming a centre in that district. The chair was taken by Dr. J. B. Wilkinson (M.O.H., Oldham), Messrs. E. R. Palmer, N. W. Hoskins, and Arthur E. Ashby (secretary) being present as a deputation from the London office. The centre was declared duly formed for the purpose of furthering the interests of the members in that district, and it was unanimously agreed that the centre would be beneficial to the objects of the Institute in raising the interests of the profession. Dr. J. B. Wilkinson was elected chairman, and Mr. H. L. Jaques (Manchester) vice-chairman, for the ensuing year, who, together with the following members, will form the local committee:—Messrs. J. Ashton, Manchester (hon. local secretary); G. V. Blaikie, Manchester; P. Leonard, Great Crosby; P. Mooney, Manchester; J. E. Entwistle, Bolton; F. Cartlidge, Leeds; C. R. Southwick, Sheffield; J. M. Lindsay, Manchester; and J. J. Quirk, Leeds.

GLASGOW SCIENTIFIC SOCIETY.—On Saturday, December 5th, a paper on "Superheating," with special reference to the Cruse controllable system of superheating, was read before the Scientific Society, Glasgow, by Mr. W. H. Booth, of London. The lecturer pointed out that superheated steam could not be treated from the thermodynamic point of view, because practically all superheat had disappeared at the point of cut-off, and the working limits of temperature were obviously the temperature of the saturated steam in the boiler, which did all the work during admission, and the temperature of the condenser. But what superheated steam did secure, or aimed to secure, was dry saturated steam at cut-off, whereby the pernicious effects of the cylinder were more or less obviated. It was pointed out that it was undesirable to carry superheat much, if at all, beyond the point of cut-off, because saturated steam contained more heat per cubic foot than was contained in superheated steam, and in a heat engine the maximum heat per unit of volume of the working fluid was what was desirable. Superheated steam, in fact, expanded by a percentage greater than its heat capacity increased. Without superheat, however, so much condensation occurred in the cylinder that a vicious cycle of condensation, re-evaporation, cooling, and general cumulative loss took place. The lecturer then described the Cruse controllable system of superheating, in which an internal pipe of circulating hot water not only kept the degree of superheat within a narrow range, but also protected the superheater pipes from overheating. In this way there was no need for dangerous flooding, and it was never necessary to shut off the hot gases from the superheater. The separately-fired superheater was also described, and the method of securing high fuel efficiency, viz., by taking up the excess temperature of the gases by means of a feed-water reheater, instead of by diluting the furnace gas with an excess of cold air, as done in uncontrolled superheaters. The control system of the separately-fired superheater is the same as that above described.

JANVIER SIX-WHEELED CAR



MOTOR CARS IN PARIS.

No. I.

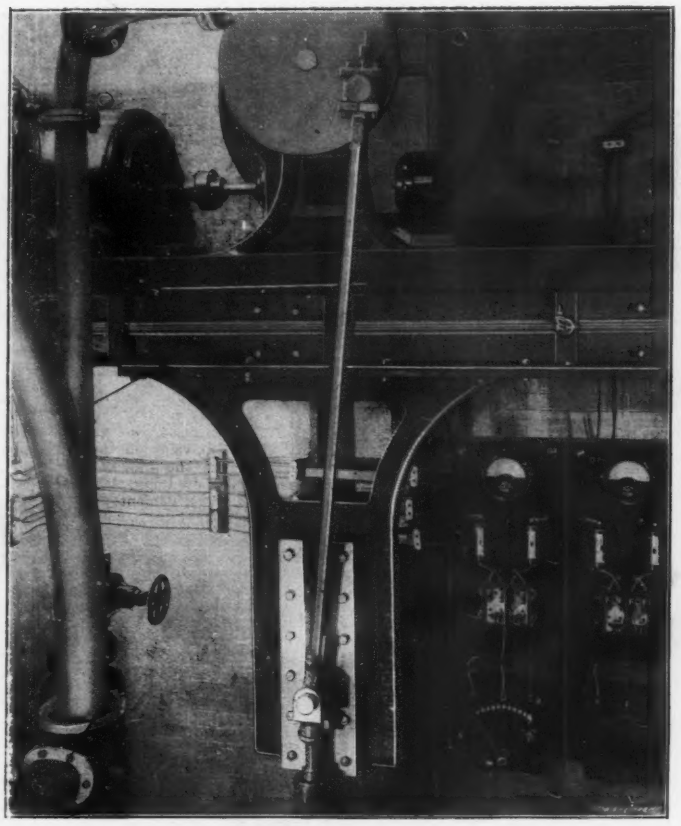
NOTHING more strikingly exemplifies the wonderful progress of the motor car industry in France than the fact, first, that the value of automobiles exported during the present year will equal, if it does not exceed, £2,000,000; and secondly, that there are more than 800 exhibitors in the sixth annual show which was inaugurated last week in Paris by the President of the Republic. The show is by far the biggest that has yet been held. As no more area can be available than what is contained in the Grand Palais, the organisers found it necessary to limit the size of the stands, and would indeed have allotted wholly inadequate areas, had not the leading firms held out against an undue restriction of space, and threatened to hold a separate show of their own if they were not permitted to make a representative display of their vehicles. No maker can now afford to neglect an opportunity of pushing the sale of his cars. At one time the business came to him, and he was often unable to execute all the orders offered, but now he has to look out for business, and competition is so keen that the majority of makers already find themselves faced with the disagreeable problem as to what will become of their huge production. The growing popularity of the automobile in France has suffered no check, nor is it likely to do so; but the use of motor cars is developing in a perfectly rational manner, while the production is being increased in a way that seems to foreshadow an early crisis unless the French are able to find a practically unlimited demand for their vehicles abroad. Already more than one-half of the cars manufactured are exported. And yet, despite the growing competition, and the fact that a good many firms have found the past season anything but a satisfactory one, there is a constant increase of productive facilities, until it becomes a question how this huge mass of vehicles can be disposed of except by cutting prices in foreign markets. We will show how this is likely to be done when we come to deal with the methods of construction.

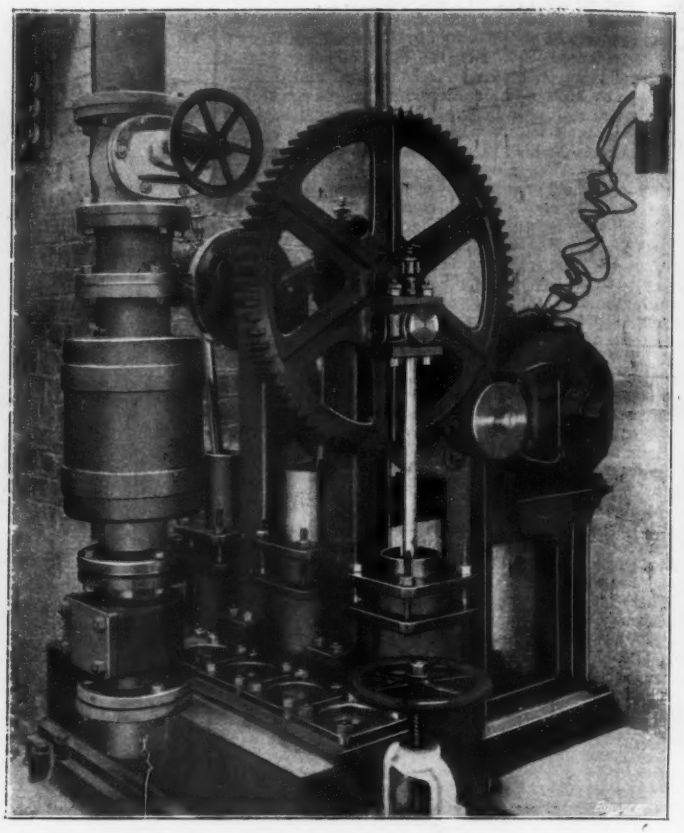
The most manifest thing about the Exhibition is the settling down to standard patterns. There are few of those novelties of a more or less extraordinary character which have made the shows so interesting in the past, but if the absence of striking devices tends to detract from the interest of the show, so far as the public are concerned, it is none the less instructive for the engineer, who can see exactly on what lines the automobile will develop in the early future. It is, of course, highly imprudent to say that the motor car has reached anything like finality. There are still a great many important problems to be solved, and it only remains for a new vehicle of recognised superiority to appear on the market for manufacturers to abandon their existing practices and adopt the new features which seem to represent an advance in automobile design. For the moment manufacturers have reached a point beyond which they find it extremely difficult to make any further headway. Nevertheless, while the new cars have undergone little change in general design, they have been wonderfully improved in silence, engine efficiency, and in the economical transmission of power, and the way in which this has been done merely by close attention to detail is a high tribute to the patience and skill of the automobile engineer. The engine and the transmission of to-day are practically the same as they were in the cars of seven or eight years ago, when the noise and vibration and wasteful absorption of power between the engine and the road wheels made it doubtful whether the motor car would ever prove satisfactory unless some entirely different system of transmission was employed. But while any number of new devices in the way of change-speed gears and the like have been tested, they have all failed to give satisfaction, and meanwhile engineers have been so patiently working on the motor to give it silence and flexibility, and upon the transmission to reduce friction, that it may be questioned whether the mechanical gear can be profitably superseded by anything else. The only difficulty lies in the limitations of the internal-combustion engine which necessitate the use of higher powers than would be required if some source of auxiliary power were available, and it is in this direction that we may look for important developments in the future. The "accumulator of energy" of M. Hospitalier, and the petrol-electric car of the Compagnie de l'Industrie Electrique et Mécanique of Geneva, are interesting conceptions to which we shall return in another article.

That it is by no means easy to make any considerable departures from existing practice is seen in the way in which the most plausible theories prove defective when put to the test. A twelvemonth ago all sorts of new theories were being put forward, some of them of a sufficiently logical character to justify the belief that they would have a marked influence upon the construction of automobiles. At that time quite a special feature was made of the flexible connections for motors and gears, these being advocated on the ground that by suspending the motor, as it were, any strains due to frame torsion would be taken off the mechanism. As the result of a year's trial all the makers, with one exception, have apparently come to the conclusion that the system of flexible connections is a fallacy. The Belgica, for example, had a three-point connection, but this has been abandoned in favour of rigidly bolting the engine to the frame, as the makers hold that diagonal frame torsion, which is so common in motor cars, must exert a strain on the motor, whether it be suspended or rigidly fixed. Apparently for the same reason the carrying of the engine longitudinally on steel bars, which pass loosely through lugs in the crank chamber, and are held by brackets on the frame, have also gone out of use. So far as we have seen, the only flexible connection is employed on the new Léon Bollée car. M. Bollée has always been a staunch upholder of flexibility, and he has evidently come to the conclusion that if flexible connections are to be used at all they must be adapted to the whole vehicle. In this car the four-cylinder engine has three connections, one on each side of the secondary frame and one in front, the latter being free to move in ball bearings. The engine, therefore, ought not to bear any strains through frame torsion, but it is evident that if the motor gives to such strains it is constantly being thrown more or less out of alignment, and though the movement is, of course, within very narrow limits, it is sufficient to interfere with the parallelism of the clutch, with the result that all sorts of cross strains are set up in the gear. M. Bollée avoids this by flexibly jointing the male cone so that it instantly adjusts itself parallel to the fly-wheel. This principle is also extended to the band brakes, which are loose inside the drums and adapt themselves with equal pressure over the internal surface of the drum as soon as pressure is applied. In the Bollée car the theory of flexibility is carried out to its logical conclusion, and apparently the results are entirely satisfactory. There are many novel features about this vehicle, which is, undoubtedly, the most silent car yet constructed; in fact, with the engine slowed down, nothing can be heard but the vibration of the trembler. This is due principally to the carburetter, which has two spray nozzles in two mixing chambers of different sizes. The theory of M. Bollée is that the capacity of the carburetter should be regulated to the quantity of gas taken by the engine. As it is highly important to use a gas of uniform quality at all speeds, attempts are made to attain this end by automatic carburetters, which adjust the admission of air to

ELECTRICALLY DRIVEN WELL AND FORCE PUMPS

MESSRS. ALFRED WILLIAMS AND CO., BOW, ENGINEERS





the quantity of spirit sucked into the mixing chamber—this quantity, of course, varying with the force of the suction strokes. These devices, however, do not always give satisfactory results. The idea of the Bollée carburetter seems to be that when the engine is running at very low speeds it is easier to accurately adjust the proportion of air and spirit in small than in large quantities. When the engine runs slow it takes gas from the small chamber, and as the speed is accelerated, the throttle of the large chamber opens automatically. There can be no doubt about the remarkable efficiency of this carburetter. There are other interesting little devices, such as the interposition of wood blocks to deaden the noise of the valve stems. They are small things, but they considerably enhance the silence and efficiency of the engine.

Small things, indeed, constitute the whole of recent improvements in motor car design. They aim at giving accessibility to the mechanism and facilitating the driving of the vehicle. In the Rochet-Schneider car the clutch is fitted with a compensating spiral spring, one end of which is attached to the gear box, so that the clutch can be thrown out with very little effort. In the F.I.A.T. a cone acts upon a very powerful spiral spring around a steel cylinder, but it was impossible to get information as to its precise action. The majority of the clutches are still of the leather-faced type, with thrust on the crank shaft, but an increasing number of makers are employing expanding clutches, some of them enclosed and running in oil. In change speed gears there is far less variety than formerly. The ordinary sliding gear has lived down all the more or less complicated devices that have aimed at superseding it, and its reliability gives general satisfaction until such time as further improvements in engines and clutches will allow of the number of wheels being reduced for, say two changes of speed. The gears are usually cut out of nickel steel, and if properly made will last almost as long as the car. There is a tendency to make the wheels broader and larger, and more firms are employing two sliding shafts, though this system is not likely to become general. Ball bearings are usually fitted on the gear shafts as well as on the thrust bearings of the crank shaft, and a typical example of this use of ball bearings is seen in the Hotchkiss car, which is shown for the first time. Like most other gun factories, the Hotchkiss Company have for a long while past been utilising their plant for the turning of gears and other automobile parts which they have been supplying to manufacturers, and they have now started upon the manufacture of the complete chassis, though it is understood that only a limited number of vehicles will be turned out. The Hotchkiss chassis is a remarkable piece of engineering work. It is designed to the standard pattern with four-cylinder engine and propeller shaft transmission, and in only a few small details, such as the novel front steering connection, is there any departure from ordinary practice. The object of the Hotchkiss Company has been to select the most approved type of car and put into it nothing but the highest class workmanship and material. It is a little curious, however, to find that in their 35 horse-power car they should be adopting the propeller shaft when all the makers, including Georges Richard-Brasier, who are the staunchest upholders of this system, have abandoned it for cars of more than 25 horse-power. After all, the efficiency and reliability of the propeller shaft depends solely upon the workmanship and material, and it is here that Hotchkiss are determined a show their skill. In the new car ball bearings are employed everywhere. There are not many firms who use ball bearings on the road wheels, but most of the leading makers now have them on the gear shafts, and there is no doubt that they contribute considerably to the efficiency of the transmission. Another exhibit that ought to be interesting is that of Creusot, who show two cars constructed to the designs of M. E. Brillié, but information about the mechanism is carefully withheld from the public on the ground that "Creusot is a State concern."

The Hotchkiss, as well as, indeed, a good half of the exhibitors, employ radiators of the honeycomb type in a more or less modified form, but these cellular tanks are by no means so generally used as might have been expected in view of their vogue a year ago. As the original form of honeycomb radiator had more than 3000 tubes, there was always a liability to leakage; but a still greater trouble is the clogging of the extremely thin walls by organic matter held in suspension. Some makers of radiators have tried to overcome the difficulty by making the cellular walls thicker, though at the same time reducing the cooling efficiency, and in the Bollée car the water is pumped through a filter before returning to the tank. On the whole, however, the honeycomb radiator is being replaced by the improved type of gill radiator, in which a rapid circulation takes place through a number of small tubes, connecting with large tubes, or collectors. This requires rather more water, but it is fully as efficient, and quite as neat, as the honeycomb radiator. While a good many makers are abandoning the honeycomb radiator, they still keep the fan, which is either driven off the end of the crank shaft or is placed behind the engine, the fan in this case forming an extension of the fly-wheel.

AUSTRALASIAN MAILS FOR 1904.—There has been issued from the office of the *Melbourne Argus* a handy booklet suitable for the pocket, consisting of 36 pages containing complete official British and foreign mail services to and from the Commonwealth of Australia and New Zealand, rates of passage, postage, and cable charges, with an excellent Orient-Pacific Line coloured track chart of the world showing distances from port to port, and differences in time.

INSTITUTION OF MECHANICAL ENGINEERS.—On Monday evening, December 14th, a meeting of the graduates of this Institution was held. The chair was taken by Mr. B. M. Jenkin, and a paper on "Main and Auxiliary Steam Pipe Work for Power Stations," was read by Mr. Henry Baker, graduate, of Warrington. The author's paper gave a most comprehensive description of the general arrangements and construction of the steam pipes used for the distribution of steam between the engines and boilers of a modern power station. The paper commenced with a description of the pipes and valves, and the usual methods adopted for an efficient drainage of the condensed water from the pipes. A description, illustrated by several wall diagrams, was next given of the various systems of pipe ranges adopted, such as the ring, double, and single main ranges. The author then discussed the merits of the different materials used for the pipes—copper, cast iron, and lap-welded or solid drawn steel—together with the means adopted to take up the large amount of expansion and contraction which takes place in long lengths of piping. The paper concluded with a description of the arrangements of the feed pumps, exhaust pipes, &c. &c. An interesting discussion followed, in which the chairman, and Messrs. Barrs, Waus, Gauvain, Howl, and Smith took part. Votes of thanks to the chairman and the retiring honorary secretary, Mr. W. P. Gauvain, terminated the proceedings.

ELECTRICALLY-DRIVEN WELL PUMPS.

THE large amount which big blocks of buildings in London have to pay for water rates has led in several instances to the sinking of private wells and to the installation of pumping plants. The latest which we have seen is that at Salisbury House, London Wall, and the work there has been carried out by Messrs. Alfred Williams and Co., of Bow. The illustrations which we give herewith show the plant which has been supplied. It possesses a number of interesting features, among which may be mentioned the use of electric motors and worm gearing for driving the deep well pumps.

All over the area of London there is, as the majority of our readers are aware, a thick deposit of clay which it is necessary to penetrate before the chalk or other water-bearing strata are reached. The thickness of this clay deposit varies considerably. In parts it is upwards of 400ft. thick. At the particular point where Salisbury House comes the thickness is much less than this; 140ft. sees the bottom of it, and below it come various kinds of sands, &c., reaching down to the chalk, which occurs at about 200ft. The Salisbury House artesian wells are driven some 250ft. into the chalk, making a total depth of bore-hole of 450ft. Throughout the depth of clay and sand, and for 15ft into the chalk, the bore-hole is lined with welded steel tubes with screwed joints. The pump is placed nearly at the bottom of this tubular lining. It consists of a foot valve and a bucket pump, both of which may be seen in Fig. 2, which figure also shows the method of jointing up the pump rods. Up at ground level the water is delivered into a cylinder, into and out of which works a plunger, which forms part of the pump rods. Both bucket and plunger are 5⅜in. in diameter. The ordinary water level before pumping is about 123ft. below ground level. It is thought that it must sink some 50ft. or so as soon as pumping is commenced, so that probably the average height pumped to ground level is some 170ft. to 180ft. The water is delivered into two tanks, which are placed on the roof of the building some 90ft. or 100ft. above ground level, so that the total lift is about 260ft. to 280ft. There are two bore tubes some 12ft. or 14ft. apart, and the discharge of each of these is said to be 3000 gallons per hour.

The arrangements of the pumps and motors is shown in Fig. 1. There has been some slight modification in the arrangement of the piping to that shown, but this is only in detail, and the illustration otherwise gives a good idea of the plant. It will be observed that the pumps, as are the bore holes, are in duplicate. The motors are geared through worm gearing to the pumps. The worms employed are of hardened steel, they are double threaded, and the pitch is 1¼in. The thrust is taken up by ball bearings, and the shaft revolves freely by a touch of a finger, as we were enabled to observe on the occasion when we inspected the plant, one of the worm wheels having been removed from its casing. The worm wheel is cut out of a ring of hard phosphor bronze bolted to a cast iron spider keyed to the shaft. We examined a worm wheel, which, we were informed, had been at work for four months, and no sign of wear could either be seen or felt. The worm and worm wheel work in an enclosed case, and the reduction of speed from the motor shaft to the pump shaft is about 38 to 1. The motor is of the enclosed type, of 18 horse-power, and runs at 850 revolutions, or a little over, per minute. The pump, therefore, when running at full speed makes some 23 or 24 strokes a minute. The worm wheel shaft is carried in phosphor bronze bearings, and at one end is fixed a disc with a pin for the bearing of the connecting-rod, and at the other a cast iron wheel with compartments cast in one side, these being filled in with lead for counterbalancing the pump rods. We observed the working of one of these pumps very carefully for some time. It was then running at about 22 revolutions a minute, the supply voltage being somewhat under the normal

400. A noticeable feature was the quietness of the working. There was little or no shock, though the water was being delivered into the tanks at the top of the building, and was therefore probably being pumped through a height of some 270ft. The connecting-rod has a slipper at its lower end, which works in a cast iron slide fixed vertically to the wall and to the underside of an overhead gallery. To the slipper are, of course, also connected the pump rods, nearly at the top of

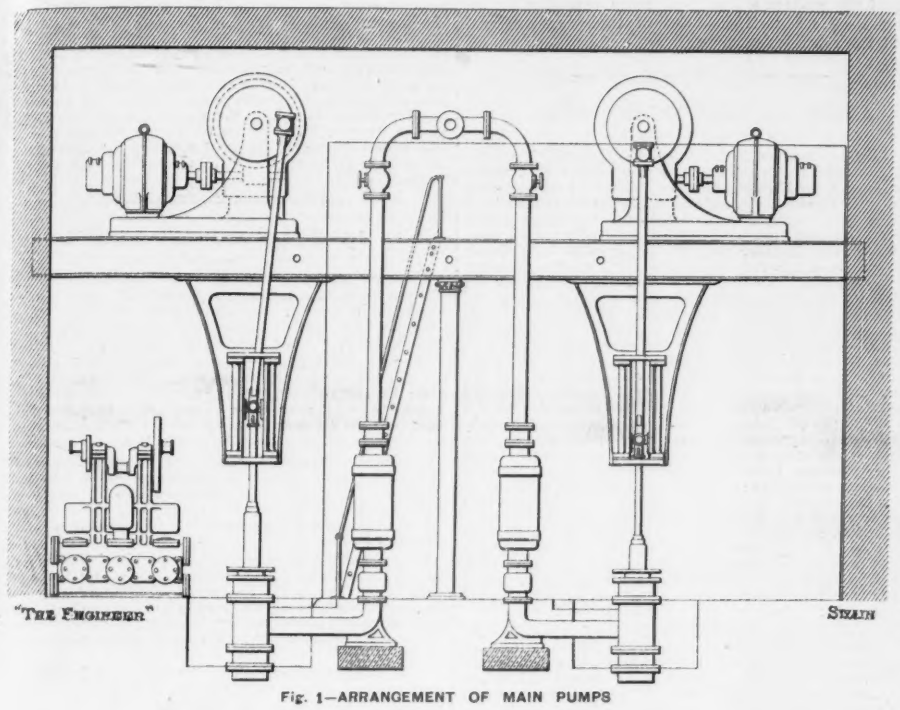


FIG. 1—ARRANGEMENT OF MAIN PUMPS

which comes the plungers, working in a gun-metal lined cylinder. The bucket works down in the well, and the plunger at the level of the engine-house floor, with some 200ft. between them. A view of one of these pumping sets is given on page 594.

The switchboard, which contains the necessary switches, fuses, instruments, &c., is placed underneath the gallery

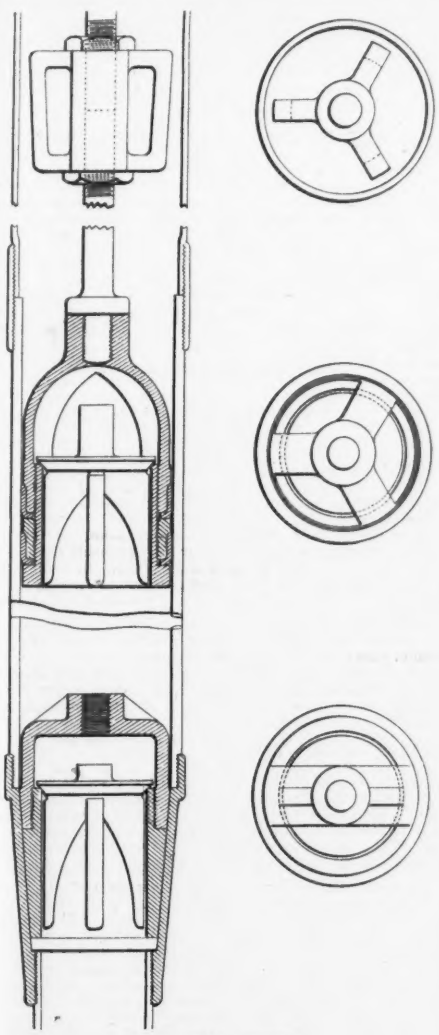


FIG. 2—WELL PUMPS

above mentioned, and from it the two main pumps, and also two circulating pumps which will be mentioned later on, are controlled.

This electric pumping plant had to be installed in the building some time after the latter was built. ¶ Consequently there were difficulties to be overcome which would not have been encountered had the plant been put in as the building went up. For example, it was found best to run the delivery pipe, which is taken to two large tanks placed on the roof of the building, up one of the lift openings. There was just room to receive it, but only just, and considerable ingenuity had to be exercised in its erection. The two tanks are of cast iron, with the angles at the bottom rounded off. They are carried on a staging of steel girders. From them there is an overflow pipe, which is carried down to another tank in the pump room. From this tank the water may be either pumped up again into the tanks on the roof or into the general service mains of the house by means of three-throw electrically-driven force pumps. These, which are in duplicate, as are the main pumps, are also placed in the pump room, and one of them is shown in the engraving on page 594. The design is compact, and it is said that the pumps work well. The general arrangement is quite evident from the engraving. The end of the shaft of the motor carries a pin which gears a toothed wheel on a shaft, the other end of which is mounted on a cowhide pinion, which in its turn gears with a machine-cut gear wheel keyed to the pump crank shaft. The pumps have three plungers, each 5in. in diameter and 7in. stroke. The suction and delivery valves are in the front, and are easily accessible. The motors are of the enclosed type, as are also those driving the main pumps. They run at 1000 revolutions per minute, and are rated at 5 brake horse-power each. The ratio of reduction of speed from motors to pumps is 26 to 1. All the rising mains are provided with air vessels, valves, &c. The whole installation struck us as being well designed and carried out.

DREDGING PLANT AND CLYDE IMPROVEMENT.

ON November 23rd there was launched from the yard of William Simons and Co., Limited, Renfrew, a powerful twin-screw barge-loading dredger, which has been built to the order of the Clyde Navigation Trustees. The new vessel, which is named the Craigiehall, was sent into the water in a completed state, and practically ready for work. She is not only the most powerful dredger now owned by the Clyde Trust, but is one of the largest and most capable dredgers of any type produced by this well-known dredger-building firm. On page 598 we give two illustrations, one showing the vessel on the stocks, and the other showing her after having been sent afloat.

She is of the bow-well bucket-ladder type, 192ft. long between perpendiculars, 38ft. breadth moulded, 13ft. depth moulded, and is divided into fourteen water-tight compartments by bulkheads, all carried up to the main deck. A raised forecastle is formed for the purpose of tying the two sides of the ship across the ladder well, and to permit of the dredger cutting its own flotation. The bucket ladder is suspended independently of the upper tumbler, and is of sufficient length to dredge to a depth of about 50ft. below the water line. Two sets of three-cylinder three-crank compound surface-condensing engines of 1000 indicated horse-power combined, fitted with steam reversing gear, are provided for propelling and dredging. Steam is supplied by two cylindrical horizontal multitubular boilers, constructed for a working pressure of 130 lb. per square inch. Auxiliary machinery in the engine-room includes independent centrifugal circulating pumps, with auxiliary air pumps attached, an automatic boiler feed pump, feed heater, feed water filter, &c.

The dredging gear is arranged to give two speeds for dredging soft and hard material with a constant speed of the engines, and the bucket ladder and dredging buckets each have a capacity of 20 cubic feet. For controlling the bucket ladder an independent steam hoist, with double friction gear, is provided, while steam manœuvring winches are fitted at bow and stern, each driven by independent two-cylinder engines, and each barrel fitted with a friction clutch and brake to enable the mooring chains to be worked independently or simultaneously as required. Shoots for loading barges are provided on both sides, and independent steam gear for controlling the shoots is provided on both sides of the dredger. Steam gear is also installed for working the shoot valve. Steam gear for steering the vessel, and a full electric installation for lighting throughout, are fitted; while cabins for officers and comfortable quarters for the crew are provided.

The Craigiehall is the latest, and designed to be the most potent, factor in securing for the port of Glasgow a broader and a deeper Clyde, a better pathway from the city to the sea; and at the luncheon which followed the launch, some interesting comments were naturally made on this subject. Mr. Andrew Brown, the principal of William Simons and Co., spoke of the long connection which the firm had had with the Clyde Trust as regards the plant employed in improving the river. So far back as 1840, while he was an apprentice in Oakbank Foundry, his first job was at the machinery of a dredger for the Clyde. The hull was built of timber by the Trust's own carpenters, and the machinery was placed on board in Renfrew Harbour. The Trustees' tug Clyde was built in Renfrew, in 1851, by Henderson and Co., and she was still running, and the only paddle tug now on the river, the paddle wheels of which work entirely independent of each other. The engines and boilers for the Clyde were constructed by A. and J. Inglis under his direction. In 1860 their firm came to Renfrew. The river was then being widened at the Renfrew Ferry preparatory to the removal of some of the rock at Elderslie. At Renfrew they built No. 2 diving bell for raising the rock as it was blasted. During 1861 the first steam hopper barges were built by the firm to the order of the Clyde Trustees. It was considered a strange notion by some people at that time to carry mud to Loch Long in a steamer. Since 1861 they had constructed for the Trustees eight hopper steamers ranging from 300 to 1200 tons, two dredging machines, two ferry steamers, and a diving bell—thirteen in all, including the Craigiehall. In 1867 the steam ferry for vehicles and passengers was put on at Govan, and in 1890 the elevating-deck ferry steamer Finnieston, the first of her type for vehicular and passenger traffic, was set to work. Both of these vessels were built by his firm. Owing to the great advance in the dimensions and draught of modern steamers, the work of the Trustees had been much increased. The dredging plant had now to be vastly more powerful and more efficient than formerly. It might ultimately become a question with the Trustees whether they should not set aside older dredgers altogether and obtain new dredging plant of greater power.

The new dredger Craigiehall is the sixth vessel of the kind which the Clyde Trust own. The others are the Cairndhu and Nos. 1, 7, 8, and 9. The Cairndhu was built about eleven years ago by Fleming and Ferguson, Paisley, and of the others No. 1 is the oldest—but thoroughly renovated—and Nos. 7, 8, and 9 follow in their order. Other dredging plant of the Trust consists of twenty-four hopper barges, including four new vessels, of 1200 tons capacity, built by Fleming and Ferguson, two of which are already in operation; two diving bells, a floating digger barge, and eighty punts which carry 10 tons of dredgings each. The new dredger and the four barges at present being added to the Clyde Trust plant will all be at work shortly. The scene of the new dredger's earliest performances will be in the neighbourhood of the Elderslie Rock. It will be employed clearing away the layer of clay and shingle at present covering the rock, and will thus enable the contractors who have undertaken to remove the rock by means of blasting to proceed effectively with the work. Blasting was also the method by which it was reduced in 1886, but on this occasion the rock will be bored and blasted to a depth of 28ft. below low water, or 7ft. lower than the depth attained seventeen years ago. Other ways, however, of removing or demolishing the rock than by the use of explosives will be employed at this time, of which something may be said later, when operations are actually proceeding.

MANCHESTER ASSOCIATION OF ENGINEERS.—At the annual general meeting of the members of the above Association, on Saturday, at the Grand Hotel, Manchester, the president, Mr. E. G. Constantine, occupying the chair, the following election of new officers was made:—President, Alfred Saxon, Openshaw; treasurer, James Walthew, Manchester; trustees, Thomas Ashbury, Manchester; Sir W. H. Bailey, Manchester; Jos. Nasmith, Manchester; Henry Webb, Bury; John West, Manchester; additional members of the Council, Sam. Boswell, W. Ingham, L. F. Massey, Thos. Roberts, John Royle.

ADMIRALTY WORKS DEPARTMENT.—An open competitive examination for the appointment of four Assistant Civil Engineers in the Works Department of H.M. naval establishments at home and abroad will be held in London, commencing on January 26th, 1904. The limit of age for candidates is 23 to 28. The salary commences at £200 per annum, and rises by £15 a year to £300 per annum. Assistant Civil Engineers will, on first appointment, be on probation for two years, and will be eligible for promotion (by selection without further examination) as vacancies occur, to the appointment of:—Civil Engineer, minimum £300, annual increment £20, maximum £550; Superintending Civil Engineer, (*a*) minimum £600, annual increment £25, maximum £750; (*b*) minimum £700, annual increment £25, maximum £850; to that of Assistant Director of Works, minimum £1000, annual increment £50, maximum £1200. Successful candidates will be required to satisfy the Medical Director-General of the Navy as to their physical fitness for the service. The fee for the examination will be £6. Further particulars may be obtained from the Director of Works, Admiralty, 21, Northumberland-avenue, London, W.C.

THE INSTITUTION OF CIVIL ENGINEERS: VISIT TO AMERICA, 1904.—Referring to a statement made by the Council at the last annual general meeting and by the President in his inaugural address, it is proposed to arrange for a party of members of the Institution to visit the United States in September, 1904. This proposal is made in response to a very cordial invitation from the Board of Direction of the American Society of Civil Engineers, who have signified their desire to render the visit as agreeable and profitable as possible. It is intended that members should travel to New York in a body, so far as that may be practicable, or otherwise should form a *rendezvous* there, where the American Society will receive them in its home, and will endeavour to arrange facilities for the party to visit objects of special interest in or near New York during a short stay in that city. It is presumed that many of the members will then desire to carry out programmes of travel in the United States which they may wish to arrange individually; and, allowing about a fortnight for such excursions, they will be enabled to visit the Universal Exhibition at St. Louis at or about the time of a Congress of Engineering, which is to be held there during the week beginning October 3rd. To this congress the members of the Institution are cordially invited, as well as to avail themselves of the use of the headquarters of the American Society, which will be situated in the Liberal Arts building of the Exhibition, where many facilities will be afforded them. No arrangements have yet been formulated with respect to the movements of members of the visiting party beyond New York, although it is possible that some proposals bearing upon this may be communicated after the party has been formed, and the general wishes of those who compose it become known. With regard to the time of returning, that will be left entirely to individual arrangement; and it is proposed to obtain facilities for the return journey to be made, if desired, so as to enable Canada to be visited. The Council, as the result of inquiry, have reason to hope that they may be enabled to secure favourable terms of passage for those who may take part in the visit, to leave Liverpool on or about September 3rd, and to return at individual choice from New York, Boston, or Halifax.

THE AUTOMOBILE CLUB'S RELIABILITY TRIALS.

FULL particulars concerning the 1000 miles trials of motor cars, which took place in September under the auspices of the Automobile Club, have now been published, and a glance down the marks earned shows that a number of cars performed the entire run with an extremely small amount of time devoted to preparation for the road—an important point to purchasers. The figures given are particularly interesting as showing in which respects the users of light motor carriages may anticipate trouble and delay. Easily foremost in this respect are ignition troubles, for which marks had to be deducted during the runs on over a hundred occasions. Anyone accustomed to driving petrol motor cars would probably expect this source of trouble to stand at the head of the list, and, indeed, it is a serious matter, and one which is well worth more careful attention on the part of builders. The fouling of the sparking plugs by the deposit of carbon, due to incomplete combustion of the fuel, is perhaps the principal cause for the failure of the spark, but short-circuits and failures of batteries are also largely to blame. The second greatest loss of marks on the road was caused by "tire troubles," of which there were no fewer than sixty-seven recorded. When it is considered that out of the hundred and odd cars entered for the competition, all but two or three—writing from memory—had pneumatic tires, this will not be a matter for surprise. The marks deducted for delays caused by the motors themselves were very few, and this bears out our experience with petrol motor cars—namely, that the engine itself is the least troublesome part of the whole. Clutch troubles and repairs to and replacing of valves were fairly frequent causes of delay, but a run of 1000 miles over dusty roads, with no time allowed for attention to these delicate details, will be sufficient to account for most of these items. The records of consumption of fuel are instructive. We find that a small steam car—the Stanley—weighing laden under 12 cwt., consumed practically 70 gallons of petrol on the entire run of 1019 miles, which works out 1·356d. per ton-mile, while a small car—the Baby Peugeot—propelled by an internal combustion engine using petrol, consumed only 26¼ gallons to accomplish the run—the cost for petrol thus working out at ·516d. per ton-mile, or little more than one-third that of the steam car. The petrol in these calculations is supposed to have cost 1s. per gallon. It should, however, be stated that the steam car alluded to is one of the light American makes. The 10 horse-power White steam car, weighing 21½ cwt. loaded, only consumed about 73 gallons for the runs, the cost per ton-mile in this case for petrol only coming out at ·780d.; while the Gardner-Serpollet steam carriage, with a laden weight of 32½ cwt., consumed 137½ gallons of heavy oil of cheap quality, shows a cost per ton-mile of ·307d. Again, the 12 horse-power Chelmsford, weighing laden 48 cwt., consumed 145 gallons of heavy oil, the cost of which comes out at ·211d. per ton-mile. We find that the best showing for petrol cars was ·300d. per ton-mile, so that in point of fuel costs there is not much to choose between the spirit when used in the explosion engine and heavy hydro-carbons consumed in steam raising.

A comparison of the columns, in which are given the horse-powers of the different cars on the one hand as stated by the makers, and on the other as calculated by the judges from performances on the trials, is amusing. One of the features of the competition was the awarding of marks for accuracy of statement of horse-power. The object of this rule was to encourage makers to sell their cars at as nearly as possible their actual brake horse-power, for it is known that certain motors are sold by different firms at varying horse-powers, and as the horse-power is largely the selling basis, the importance of uniformity to the buyer is of importance. The marks under this heading were arrived at by a formula taking into consideration the actual weight of the car and the length and rise of the hill, together with the time taken in ascending the hill, and a coefficient of traction resistance and loss in transmission. The rule—(48)—is as follows:—

A total of 250 marks shall be awarded to the car which is shown by actual performance on the hill to have given a horse-power equal to or most nearly equal to the horse-power at which it is described on the entry form. These marks shall be arrived at by the following formula:—

$$250 \times \left(\frac{140}{100} \times \frac{\text{H.P. performance}}{\text{H.P. declared}}\right)^3;$$

the H.P. performance being arrived at by the following formula:—

$$\frac{\text{(Laden weight of car in lb.} \times \text{vertical rise of hill in feet)} + \text{(length of hill in feet} \times 40 \text{ lb. per ton laden weight)}}{33{,}000 \times \text{time taken in ascending hill in minutes.}}$$

The marks earned by the steam cars under this heading are naturally high; the Gardner-Serpollet car declared at 10 horse-power actually giving on the hills 19·8 horse-power at the wheels; the Chelmsford steam car declared at 12 horse-power gave 17·9 horse-power on the hills; the 10 horse-power White car gave 9·1 horse-power; and the Stanley steam car declared at 5½ horse-power gave 3·9 horse-power on the hills. Turning to petrol cars, we find the so-called 5 horse-power Coventry Humberette, under this calculation, giving 1·9 horse-power; the 10 horse-power Rex comes out with 3·6 horse-power; the 10 horse-power Simms Welbeck gives 3·8 horse-power; the 25 horse-power Maudslay yields 9·3 horse-power. On the other hand, the 16 horse-power Rochet-Schneider petrol car gives under this formula 15 horse-power; the 14 horse-power Martini, 12·4 horse-power; the 12 horse-power New Orleans, 11·6 horse-power; and the 12 horse-power and 10 horse-power Wolseleys 8·6 and 8·5 horse-power respectively. What conclusion will the prospective purchaser arrive at on the point of horse-power? The system of transmission employed in many of these cars is almost identical, but the power given off varies to an extent which is out of all reason. Obviously the declared powers are in most cases quite misleading, and this part of the test will only be of service when the motors themselves have been previously tested on the brake by the judges. Then when the motor and car are tested collectively on the hill, the mechanical efficiency of the whole is obtainable, and the loss of power in transmission can be arrived at within reasonable limits. In the meantime, it is high time that some of the makers either paid more attention to accuracy in the advertised power of their cars or overhauled their transmission gear.

AMERICAN ENGINEERING NEWS.

(*From our own Correspondent.*)

An American report on Niclausse boilers.—A Special Board has recently reported to the United States Navy Department on the performance of the Niclausse water-tube boilers of the battleship Maine. There are twenty-four boilers in three batteries, with a funnel to each battery. Each boiler is composed of fifteen elements, and each element contains twenty-four tubes 3½in. outside diameter, 7ft. 3in. long, and No. 8 gauge in thickness. Inside each tube is a circulating tube 1⅝in. outside diameter, No. 4 gauge thick. There are blowers for forced draught on the closed fire-room system, but these were not used. The trip occupied about 160 hours at 15 to 16 knots. On the first part there was no trouble, the fires being carried evenly and kept moderately thick. No attempt was made to force the fires, and the coal consumption averaged 18·72 lb. per square foot of grate. There was some difficulty in maintaining the required pressure for 115 revolutions, but this was due to inexperienced firemen, and it was evident that with such a multiplicity of units systematic firing is essential to keep all the boilers doing their share of the work. On the return trip, with a chief water tender in charge of all the fire-rooms, there was no trouble in keeping up pressure enough for 120 revolutions. It was found that practically all the tubes of the two bottom rows were sent, but not enough to require removal. With a fixed rate of combustion they will probably bend to a certain extent, and no further bending will occur unless the rate of combustion is changed. The Board considers the boilers fully equal to their work, if given the care necessary for the efficiency of every water-tube boiler. It also considers that clean fresh water is necessary for any water-tube boiler, and is no more a specialty for the Niclausse than for any other boiler of the large tube type.

Mine hoisting engine.—The Oliver Ian Mining Company, U.S.A., has two new mines 700ft. deep, raising 500 to 700 tons a day, and intended to ultimately reach a depth of 2000ft. The hoisting from both mines is done by a two-cylinder Corliss engine of 2000 horse-power, having two drums on the shaft, which are thrown in and out of gear by friction clutches. It works under steam of 150 lb. pressure. The hoisting capacity of each drum is 14½ tons; seven tons of ore, three tons of rope, 2½ tons for the skip and two tons for the cage. The hoisting speed is 2000ft. per minute. The engine has cylinders 28in. by 60in., at opposite ends of a 14in. main shaft, with crank pins 8in. by 8in. The slides are bored out to a diameter of 30in. for the segmental shoes of the crosshead. Each cylinder is fitted with a by-pass connecting its ends, which allows the piston to move freely when the cage is descending. The ports and passages are so designed as to give a maximum velocity of steam of 6000ft. per minute for admission and 4000ft. for exhaust. There are no excentrics, but a train of gear from the engine shaft drives a valve shaft, from which run connecting-rods to the wrist plate carrying the four valve rods. Upon this shaft is a threaded portion enclosed by a sliding and operated by hydraulic cylinders, and by thus shifting the shaft the engine is reversed. The hoisting drums are 9ft. long and 14ft. diameter, grooved for 1⅜in. wire cable, and able to carry 2000ft. of this cable. On each end of each drum is a band brake, both bands operated by a steam cylinder. In case the steam pressure should fall below 100 lb., an automatic valve would admit compressed air at 60 lb. pressure into the brake cylinder, thus applying and holding the brake.

An American superheater.—A new make of superheater which is now being introduced in the United States belongs to the "independent" type, being entirely distinct from the boiler and having its own furnace, while the steam from the boiler passes through the superheater on its way to the engine. This type now has many advocates, for mechanical and commercial reasons, and it can be applied to existing plants without disturbing the boiler equipment. The superheater consists of a furnace of the reverberatory form, from which the gases pass over the bridge wall, down through the combustion chamber, and thence up through the horizontal rows of heater tubes. These tubes extend across the chamber and connect with headers at each side. The steam enters the top header at one side, and passes through the top row of tubes to the opposite header, from which it passes back through the next lower row of tubes until it reaches the lowest header, from which it is led to the engine. As the steam descends the superheating gases become hotter and hotter, and these gases are compelled to pass all the rows of tubes in a direction transverse to their length before they reach the connection to the chimney flue. The bridge wall of the furnace is hollow, with openings to the air at each end, these openings being fitted with sliding shutters. From this transverse chamber, openings lead through the back of the bridge wall, where it mingles with the products of combustion passing over the wall and down to the combustion chamber. By this provision of regulating the temperature of the gases, a very uniform degree of superheating can be maintained, even where there is a wide variation in the quantity of steam passing.

American nickel steel boiler tubes.—Steel boiler tubes containing enough nickel to make them non-corrosive were manufactured in Europe in 1898, and were first made in the United States in February, 1903. These tubes, containing 30 per cent. nickel, are now regularly on the market as seamless, cold-drawn, marine boiler tubes. They are made in practically the same number of operations, and with but a slightly greater percentage of discard than is customary in the manufacture of ordinary seamless tubes. These tubes will stand all the manipulating tests required by the specifications of the Bureau of Steam Engineering, United States Navy, for the carbon steel, seamless, cold-drawn tubes now in use, and in addition to this the nickel steel tubes have a much higher tensile strength. The greater strength and elastic limit enables a thinner and lighter tube to be used, which partly offsets their higher cost by weight, and also increases the steaming efficiency of the boiler. The Navy Department estimates that by the use of nickel steel tubes the total weight of boilers would be reduced by from 10 tons in torpedo boats to 38 tons in battleships. While the price per pound is very much higher, the tubes will last twice as long, and will have a higher scrap value when removed. In expanding the tubes greater care is required than with mild steel or charcoal iron tubes. In locomotive boilers, leakages at the tube sheets often result from the expansion of the sheets compressing the soft steel tubes. To prevent this at reasonable cost, the plan is being tried of welding a 3in. length of 30 per cent. nickel steel tube on to a piece of soft steel tube, which, later, can be welded on to the end of an old boiler tube removed for repairs. About 1000 of these "safe-end" tubes have been delivered to several American railways.

Hundred and seventeen-ton bank engine.—For assisting heavy coal trains over certain steep gradients the Lake Shore and Michigan Southern Railway, U.S.A., has had built five bank or pusher engines of 117 tons weight, with 103 tons on the drivers. There are eight coupled driving wheels, 4ft. 9in. diameter, and a two-wheeled leading bogie. The driving axle journals are 10in. by 12in. and 9½in. by 12in. The cylinders are 23in. by 30in. To give sufficient steam capacity there is an immense boiler 6ft. 8in. to 7ft. 3in. diameter, with 460 tubes 2in. diameter and 15½ft. long. The boiler is mounted with its centre line 10ft. above the rails, and it carries a pressure of 200 lb. The heating surface is 3957 square feet, of which 3725ft. are in the tubes, 203ft. in the fire-box and 29ft. in the four water tubes carrying the fire-brick arch. The fire-box is of the wide type, extending over the frames and having 55 square feet of grate area. The frames are of cast steel, and behind the rear driving axle they are dropped to bring the tender draw-bar connection in line with the centre of the axle. The funnel is 4ft. high, but only 22in. extend above the smoke-box, its top even then being 15ft. 3in. above the rails. The third axle is the main driving axle, with crank-pins 7½in. by 7in. Piston slide valves are used, with an inside diameter of 13in. The tender has an underframe of rolled steel channels, and is carried on a pair of four-wheeled bogies whose bolsters and transoms are specially designed to keep the centre of gravity of the tender as low as possible. The tender carries 16 tons of coal and 7500 gallons of water. The total weight of the engine in working order is 117 tons, or 193 tons including both engine and tender.

LAUNCHES AND TRIAL TRIPS.

FOO-SHING, steel screw steamer; built by, Swan, Hunter and Wigham Richardson, Limited; to the order of, Indo-China Steam Navigation Company; dimensions, 290ft. by 42ft.; to carry, European and Chinese passengers; engines, triple-expansion; constructed by, builders; launch, December 3rd.

LEOPOLDVILLE, twin screw steamer; built by, Sir Raylton Dixon and Co; to the order of, Messrs. Elder Dempster and Co., Liverpool; dimensions, 390ft., 47ft., by 26ft.; to carry, mails and 140 passengers; engines, triple expansion, 21½in., 36in., and 59in. by 42in., pressure 180 lb.; constructed by, the Wallsend Slipway and Engineering Company, Limited; launch, December 5th.

CAMPHOS, steel twin screw steamer; built by, Messrs. Craig, Taylor and Co., to the order of, the Companhia Sao Joao da Barra E. Campos, Rio de Janeiro; dimensions, 209ft. by 33ft. by 10ft.; engines, triple-expansion, 11in., 17in., 28in., and 21in., pressure 160 lb.; for light draught services in the South of Brazil; launch, December 5th.

ITALIA, steel screw steamer; built by, David and William Henderson and Co., Limited; to the order of, the Anchor Line; dimensions, 400ft., 49ft., by 30ft. 9in.; to carry, 7000 tons deadweight and passengers; engines, triple-expansion, 30in., 50½in., 85in., by 54in., pressure 200 lb.; constructed by, builders; this vessel is intended for the Mediterranean and New York passenger service; launch, December 7th.

VERA, cargo steamer; built by, the Laxevaags Engineering and Shipbuilding Company, Bergen; dimensions, 224ft., 32ft. 6in. by 15ft. 1in.; to carry, 1300 tons deadweight; engines, triple-expansion, 16in., 25½in., 43in. by 30in., pressure 175 lb.; constructed by, builders; trial trip, December 7th.

SAN LORENZO, steel screw steamer; built by, Craig, Taylor and Co.; to the order of, South American owners; dimensions, 208ft., 30ft. by 20ft.; to carry, cattle and cargo; engines, triple expansion, 18in., 30in., 48in. by 33in, pressure 180 lb.; constructed by, North-Eastern Marine Engineering Company; a speed 13¼ knots was attained; trial trip, December 11th.

RABENFELS; built by, Swan, Hunter and Wigham Richardsons, Limited; to the order of, the Deutsche, D. G. "Hansa," of Bremen; dimensions, 400ft. by 51½ft. beam; engines, quadruple-expansion, balanced on Yarrow, Schlick, and Tweedy system, constructed by, the builders; trial trip, December 15th.

ALMANACS AND CALENDARS FOR 1904.

WE have received from the United States Metallic Packing Company, Limited, Bradford, a wall calendar of unique design and displaying considerable artistic feeling. The main feature is the recumbent head of a woman and Cupid produced in white and in relief on a dark green background. The slips are of the monthly tear-off variety. Messrs. Thomas Robinson and Son, Limited, Rochdale, have published a wall calendar, the most noteworthy feature of which are the quotations, or mottoes, at the foot of the pad. These mottoes are not of the conventional and purely sentimental variety, but are suitable for business application.

THE KERKA ELECTRIC POWER WORKS IN DALMATIA, developing an energy of 20,000 horse-power, will be opened very shortly. This energy will be transmitted to Sebenico, for the production of "carbide of lime." The transmission line will be nearly 7½ miles long. The central electric station at Jaruga—on the left border of the Kerka—is composed of two groups of 3500 horse-power each. With such a force, an annual production of 5000 tons of carbide of lime is anticipated. The company for the utilisation of hydraulic power of Dalmatia, known under the name of "Società Romana," has also begun the works of the Manojlovac waterfall. The company hopes to obtain electric energy of 25,000 horse-power. There will be altogether 30,000 horse-power from the four Kerka waterfalls; and the annual production of the carbide of lime will be 30,000 tons.

TRADES UNION TYRANNY IN AMERICA.—The summary of trade union outrages in the United States during October, in addition to the customary list of murders, assaults, and cases of trade union members who have been reduced to destitution and driven to crime by not being allowed to work, includes the closing of a shipbuilding establishment which had done a prosperous business and maintained an extended pay roll through many years, but by yielding to trade-union demands had become so subject to labour tyranny that it was forced completely out of business. Another instance is of one of the best known publishing establishments in the United States abandoning plans for a million dollar plant in the city in which it has given employment to thousands of men for half a century because the demands of the labour unions have made it unable to compete with similar establishments in other cities not so hampered.—*Railroad Gazette.*

NICLAUSSE BOILERS OF THE U.S. BATTLESHIP MAINE.—Tests made by a special Board appointed by the Navy Department have resulted satisfactorily. The Board says:—"These boilers of the Maine are a fine example of mechanical work, and to keep them in proper order will require the services of men of intelligence and mechanical skill. The Board was impressed with the obvious fact that the quality of the *personnel* is of more importance than the quantity. The water-tube boiler calls for more brain work, and at the same time less physical effort on the part of the fireman. To get this quality of fireman he will have to be specially trained. The custom on board the Maine now is that when necessary to take out tubes the fireman and water tenders take them out, while the machinists and boilermakers put them in. With the experience now acquired these men have become very proficient; the average time to remove a tube and replace one is about fifteen minutes, provided the generating tube does not turn with the effort required to unscrew the lantern plug. A suitable tool is provided to hold a turning tube."

RAILWAY MATTERS.

IT is proposed to begin early in 1904 the conversion of the Streatham cable tramway into an electrical conduit system at a cost of £107,300.

WE understand that Mr. T. R. Fearnley, general manager of the Birkenhead Corporation Tramways, has been unanimously selected for recommendation for the office of general manager of the Sheffield Corporation Tramways.

THE members of the Midland Company's engineering staff are measuring the bridges on the Settle and Carlisle sections of the line for stronger girders, considered necessary owing to the greatly increased weight of the new locomotives.

THE Royal Commission appointed in March to inquire into the working of the South Australian Railways recommend the Government to obtain a report and estimate of the cost of electrifying the suburban railway services from a competent electrical engineer.

THE Board of Trade have recently confirmed the Avonmouth Light Railway Order, 1903, authorising the construction of a light railway in the county of Gloucester in the parishes of Henbury and Shirehampton; and the Maidstone Corporation Light Railways Order, 1903, authorising the construction of a light railway in the borough of Maidstone.

THE North-Eastern Railway Company, which recently installed an all-electric signalling system at York goods yard, has now introduced a large installation of electro-pneumatic signalling on the Sunderland and South Shields line at Harton Colliery. In order to ascertain the relative merits of the three power-signalling systems now engaging the attention of British railway officials, the North-Eastern will also shortly lay an experimental installation of low-pressure air signalling at the Paragon Station, Hull.

ACCORDING to reports just to hand, a large section of the Orenburg-Tashkent Railway has been inundated, in places to a depth of over 50ft., by an overflow of the Syr Daria. It appears that the railway in question is being constructed for some 460 miles through the valley of the Syr Daria, and for a distance of about 330 miles it runs within the zone subject to the inundations of this river. This defect in the projected route of the new railway was pointed out in St. Petersburg by experts two and a-half years ago.

THE reconstruction of the Aston tramway route is, so far as the portion in the city of Birmingham is concerned, expected to be completed by the last day of the present year, when the lease expires, and the line will be worked on the overhead traction principle by the Birmingham Corporation. In Aston Manor, however, the work of transformation is not so well advanced, and probably an additional month will elapse before the British Electric Traction Company, to whom the Aston authorities have leased their interests, will be able to join with the Corporation of Birmingham in a through service to the Lower Grounds and Witton.

CONTRACTS are stated to have been signed for extensions of the South Lancashire Company's tramway system, totalling about 40 miles. They provide the laying of lines from the Leigh boundary to the Great Central Railway Company's station at Lowton; from Tyldesley to the Worsley boundary at Boothstown, and from Hindley to the Bolton Corporation's terminus at Deane. A start, it is also expected, will before long be made with the routes from Bolton, *viâ* Walkden, to Swinton; from Worsley to Irlams-o'-th'-Height, and from Leigh to Newton-le-Willows. The company is at present working some 30 miles of tramways from their central generating works at Atherton.

SIX new saloons have been built by the London and North-Western Railway at Wolverton works, from the designs of Mr. C. A. Park, carriage superintendent. These vehicles have been designed to run in the Royal train along with the two Royal saloons, built last year for the exclusive use of the King and Queen, but they will also be available in place of ordinary private saloons for those who are willing to pay something more than the usual charge for the extra luxury they afford. The vehicles are 57ft. long over the bodies, and each is divided into four compartments; two in the centre are each 8¼ft. long by 8½ft. wide; while the smaller ones at each end are each 8ft. long by 6½ft. wide.

THE extensions for which parliamentary approval is to be sought by the London United Tramways Company in the next session of Parliament total 21½ miles. This is apart from 31¾ miles of lines in operation, and another 45¼ miles already authorised, making altogether 98½ miles of lines. These latter comprise an extension from Southall to Hayes, Hillingdon, and Uxbridge, and a short cross-country line from Hammersmith to Acton Gate. But the most important are the Surrey extensions. From Molesey there is to be connection with Surbiton by way of Thames Ditton. From Surbiton a line is to run south to Hook, and another north to Kingston. Here there is to be connection with Hampton Wick, and a line is to run due east to New Malden and Wimbledon.

THE gross receipts of the East Indian Railway Company in the half-year ended June 30th amounted to Rs. 3,76,57,612, or Rs. 4,58,955, in excess of those received in the corresponding half of 1902. Working expenses came to Rs. 1,22,68,984, or a decrease of Rs. 7,54,842, and the net revenue of Rs. 2,53,88,628 was Rs. 12,13,797 more than in 1902. The percentages of working expenses upon the gross receipts of the two half-years were 32·58 and 35·01 respectively. A decrease in the train mileage run during the half-year was not due to any falling off in the traffic, but arose from a reduction in the goods train mileage of 484,231 miles, accompanied by an increase of about 3 per cent. in the total ton mileage, and an improvement of about 12 per cent. in the train loads. There was an increase of coaching mileage of 309,307 miles, with a nearly equal proportion of increase in the receipts.

THE total number of applications made to the Light Railway Commissioners in November for orders to authorise light railways was seventeen, of which twelve ask for powers to construct. The twelve new applications are for 62,$\frac{1}{10}$ miles, and the cost of construction, exclusive of equipment and rolling stock, is estimated at £454,483. Electricity is proposed as the motive power in eight schemes of the total length of 30,$\frac{7}{10}$ miles, while power is sought to use steam or electricity in the remaining four schemes, totalling 31¾ miles. The standard gauge of 4ft. 8½in. is proposed in seven cases, totalling 44 miles, and 3ft. 6in. in three cases, totalling only 2$\frac{7}{10}$ miles, while two cases of the total length of 15¼ miles propose the narrow gauge of 1ft. 11½in., commonly called the 2ft. gauge. These two schemes are for railways in the Snowdon Mountain district in extension of the North Wales Narrow Gauge Railways.

THE report of the Burma Railways Company for the year July, 1902—June, 1903, states that the open mileage has increased from 1178·25 to 1336·97. The passenger traffic has generally been most satisfactory. It accounts practically for the whole of the increase in the gross earnings. A portion of the increase is due to the extra open mileage, the receipts on the Bassein-Henzada line being especially promising. The goods earnings, taken as a whole, show no increase; the traffic on the new lines opened was small, and more time is required for its development. On the older portion of the line the traffic was generally satisfactory, but in the principal commodity carried, rice, there was a falling off. A scheme for the gradual replacement of the older locomotives is under consideration, but it is hoped that the cost of such replacement will be, to some extent, met by the reduction of the repair outlay to which such engines largely contribute.

NOTES AND MEMORANDA.

TOKYO, with a population of about one and a-half millions, has 10,554 subscribers to the telephone service.

THE number of stamps at work in the Transvaal gold-mining industry in October last was 4490, an increase of 135 compared with September.

IT would appear that the honeycomb type of radiator for petrol motor cars is not likely to meet with the same degree of favour in the future that it enjoyed during the past year. The average honeycomb radiator contains no fewer than 4000 tubes with hexagonal ends, making the number of soldered joints, in plain figures, 24,000.

A FORGING has just been completed by Messrs. W. Somers and Co., Hales Owen, which is worth noticing. It is a gigantic screw, 85ft. 7in. long and 11½in. in diameter, and has been forged for a 150-ton "shear legs." It was forged from one ingot of steel, has a 2in. thread extending nearly its entire length, and is 17½ tons in weight.

A CONSIDERABLE increase has taken place this year in the exportation of steel rails from Germany. The latest returns available are those for the nine months ending with September last, during which period the shipments reached a total of 307,204 tons, as compared with 238,578 tons in the corresponding period of last year, and 125,538 tons in the first nine months of 1901.

DURING November Scotch shipbuilders launched 21 vessels, of about 29,219 tons gross, as compared with 22 vessels, of 45,819 tons gross, in October, and 32 vessels, of 48,549 tons gross, in November last year. In the eleven months Scotch builders have launched 266 vessels, of 406,292 tons gross, as compared with 290 vessels, of 494,818 tons gross, in the corresponding period of last year.

THE latest novelty in petrol engines is a motor in which one mechanically-operated valve serves for both admission and exhaust functions. The working is effected by the aid of a sliding sleeve which surrounds the valve and a peculiar shaped cam giving two various degrees of lift to the valve. The engine is being introduced by Mr. O. C. Selbach, Great Russell-street, London.

ENGLISH shipbuilders last month put into the water 24 steamers, of 59,270 tons gross, against 25 vessels, of 57,958 tons gross, in October, 25 vessels, of 49,360 tons gross, in November last year. During the past eleven months English builders have launched 272 vessels, aggregating 562,851 tons gross, as compared with 251 vessels, of about 646,443 tons gross, in the corresponding period of last year.

THE value of the agricultural implements exported from the United States last year was £4,200,000; France was the largest importer, having bought nearly £600,000 worth; an equal amount went to Argentina; £300,000 worth was taken by the United Kingdom; Germany took about the same amount; Australia imported implements worth £250,000; and to Africa there was sent £200,000 worth of these implements.

WHAT is believed to be the first iron casting made in the territory now included in the United States, is preserved in Lynn, Mass. Its history is well authenticated. It is a cooking-pot, weighing a little over 2 lb. It was made about 1642, near Lynn, where a small blast furnace was built in that year. This furnace used charcoal for fuel, with bog ore, found in the meadows along the Saugus river, and oyster shells as flux. This furnace, according to the *Engineering and Mining Journal*, was operated until 1688, with some intermissions.

THE filaments in incandescent lamps gradually diminishes in diameter in consequence of the slow volatilisation of the carbon. According to the *Elektrotechnische Rundschau*, a German firm introduces into the glass globe certain chemical compounds with a high boiling point, which, under the influence of the temperature in the lamp bulb, slowly give off vapours containing carbon. The latter is deposited on the filament, thus making up to a large extent for the loss referred to above, and keeping the resistance and also the brightness of the lamp more uniform throughout its useful life.

IF the conclusions reached by a board of three of the most expert engineer officers in the service are adopted, the United States Navy Department will soon begin the construction of turbine boats, says the *Army and Navy Journal*. After an exhaustive test of the steam turbine as applied to a fast yacht recently, collecting data from every available source, and advising with the best engineering talent in the country, the board, which consisted of Commander Alfred B. Canaga and Lieut.-Commanders John R. Edwards and Wythe M. Parks, all of the Bureau of Steam Engineering, has supplemented this theoretical study with a practical demonstration of the workings of the steamship Revolution, and has submitted to the Navy Department an important report.

AN open competitive examination for the appointment of four assistant civil engineers in the Works Department of his Majesty's naval establishments at home and abroad will be held in London, commencing on January 26th, 1904. The limit of age for candidates is twenty-three and twenty-eight. The salary commences at £200 per annum, and rises by £15 a year to £300 per annum. Assistant civil engineers will, on first appointment, be on probation for two years, and will be eligible for promotion—by selection without further examination—as vacancies occur, to the appointment of—civil engineers, minimum £300, annual increment £20, maximum £550; superintending civil engineer (*a*), minimum £600, annual increment £25, maximum £750; (*b*), minimum £700, annual increment £25, maximum £850; to that of assistant director of works minimum £1000, annual increment £50, maximum £1200.

A NEW apparatus for the measurement of small inductances has been devised by Messrs. W. Stroud and J. H. Oates. Its essential feature consists in the employment of what is substantially a movable coil d'Arsonval galvanometer, in which the permanent magnet is replaced by an electro-magnet, with a laminated iron core, actuated by a 100-volt alternating current. The solid iron core inside the moving coil of the ordinary d'Arsonval is in this instrument also replaced by a laminated one. The instrument, says *The Electrician*, is used like an electro-dynamometer when arranged for measuring the conductivity of electrolytes. The field magnet is placed across the mains, and the movable coil is used to replace the galvanometer in the bridge. The key must be in the battery circuit. The apparatus may be used for measuring an inductance with certainty to something well under one-tenth of a millihenry.

SOME authentic figures relating to the much-talked-of Edison accumulator for motor cars are now available. According to the paper read before the Institution of Electrical Engineers recently by Mr. W. Hibbert, taking the output at 210 watt-hours at 60 ampères, and the weight at 17·8 lb., the specific output amounts to 11·8 watt-hours per pound of cell. This must be regarded as a high figure, but not so remarkable as might have been expected from the numerous glowing reports which have been published. Tested on the bench, the battery has an efficiency varying from 66 to 50 per cent. Charged and discharged at 60 ampères, it is about 60 per cent. Charged at 100 ampères and discharged at 60, the efficiency is 56 per cent. Charged for one hour at 177 ampère rate and discharged at 60 ampères, the efficiency is 50 per cent. These figures are lower than would be found with good lead traction cells under the same condition of discharge following immediately after charge.

MISCELLANEA.

BY the fall of a girder, which smashed a gas main, Norwich was without gas for half an hour on Saturday.

WE regret to have to announce the death of Mr. James Walthew, of Manchester. For forty-three years he was associated with the firm of Galloways Limited, and retired in 1895. Mr. Walthew was a past-president of the Manchester Association of Engineers, and for some years had filled the office of treasurer. He will be greatly missed in connection with social and philanthropic work.

IT is announced that the order for the tramway rails, fish-plates, and flange rails required by the Corporation of Johannesburg, has been secured by Bolckow, Vaughan and Co., Middlesbrough. The total quantity required is about 7000 tons, and the value of the order is over £40,000. The order for the points and crossings for the same tramways has been secured by Hadfield's Steel Foundry Company, Limited, Sheffield.

THE Secretary for War has decided, in respect to the outfit allowance for officers of the Motor Volunteer Corps, that the ordinary driving certificate of the Automobile Club of Great Britain and Ireland, countersigned by the Officer Commanding the Corps, may be accepted as the qualifying certificate for the allowance. A refund of the allowance will be required in the case of any officer who fails to serve for three years as an efficient.

A SCHEME for another great universal exhibition is being talked of in Paris, while a counter-proposal which has met with much support is that, instead of holding in one year one huge exhibition of all the arts and manufactures, Paris should have a series of annual shows devoted to different branches of industry. It is proposed that the first of these should be opened in 1905, and be devoted to automobilism and all the latest devices in transit and traction.

THE general dimensions and features of the two 13,000-ton battleships which are to be built for the U.S. navy are as follows:—Length of load water line, 375ft.; breadth, extreme, at load water line, 77ft.; displacement on trial, not more than 13,000 tons; mean draught to bottom of keel at trial displacement, 24ft. 8in.; mean gross draught, full load about 27ft. 1½in.; total coal bunker capacity, about 1750 tons; coal carried on trial, 600 tons; feed water carried on trial, 40 tons.

AN address recently given to the Indianapolis Manufacturers' Club on "Smoke Prevention," "Fuel Costs," and kindred subjects, by Mr. C. Huyatt, of Chicago, says that statistics show that the cost of producing one unit of power is less in Indianapolis than in any other large city in the United States. The cost there is 8 cents, he says, as compared to 16 cents in Chicago. In other cities it varies from slightly higher than Indianapolis up to 30 cents. He says there is not one chimney in a hundred that is high enough.

THE trustees of the Port of Bombay, at a meeting held on November 17th, 1903, decided to invite tenders for the construction of the large new wet and dry docks proposed for that port from the leading firms having experience of dock and harbour works. The date fixed for the submission of tenders is March 1st, 1904. The scheme has been approved by Government; but the acceptance of tenders is subject to sanction to the detailed plans and estimates which have been submitted for their consideration.

THE Chief Constable of Manchester has recommended the Watch Committee not to make application to the Local Government Board for power to restrict the speed of motor cars to 10 miles per hour at present, but to wait until the Act has been in operation a reasonable length of time, and until experience has been gained as to the manner in which it works in practice. The Chief Constable is under the impression that few persons will, in a city like Manchester, drive through the principal thoroughfares at a greater speed than 10 miles an hour. The Committee has adopted the recommendation.

THE Waterworks Committee of the Manchester Corporation this week paid a visit to the city waterworks at Longdendale and inspected the Bottoms reservoir and the gauge basin through which flows the compensation water before it passes into the river Etherow. The Committee, according to the *Manchester Guardian*, have under consideration a scheme for utilising the force of the flow of water so that their workshops in proximity may be driven and lighted by electricity. It is also proposed to work by overhead traction the private railway belonging to the city, which runs along by the reservoirs to a large stone quarry on the estate, and thus to develop the quarry.

THE sum of 2,000,000 marks has been voted in the German estimates for 1904 as a second instalment of the State contribution towards securing the representation of the German Empire at the St. Louis World's Fair, making, with the 1,500,000 marks already voted, a total of 3,500,000 marks, or £175,000. A memorandum submitted to the Reichstag states that the German building is being erected upon the best site in the Exhibition grounds, and recommends that exact reproductions should be made of distinctive rooms which have been or are being designed and decorated to the order of various public bodies, and that these should be used for the display of the exhibits.

AT the meeting of the London County Council on Tuesday the Parliamentary Committee brought up the Thames River Steamboat Service Bill, 1904, which seeks to establish an efficient service of steamboats on the river, and for that purpose to take over, administer, and alter, where necessary, the existing, and also to construct additional, piers. As in last year's Bill, compulsory powers of acquisition are sought over Greenwich Pier. The Bill follows the lines of similar Bills approved by the Council on previous occasions. The Bill includes an estimate of capital expenditure, amounting to £280,000, in respect of the construction of steamboats, and the acquisition of, and improvements at, piers. The Bill was approved and ordered to be introduced in the usual way.

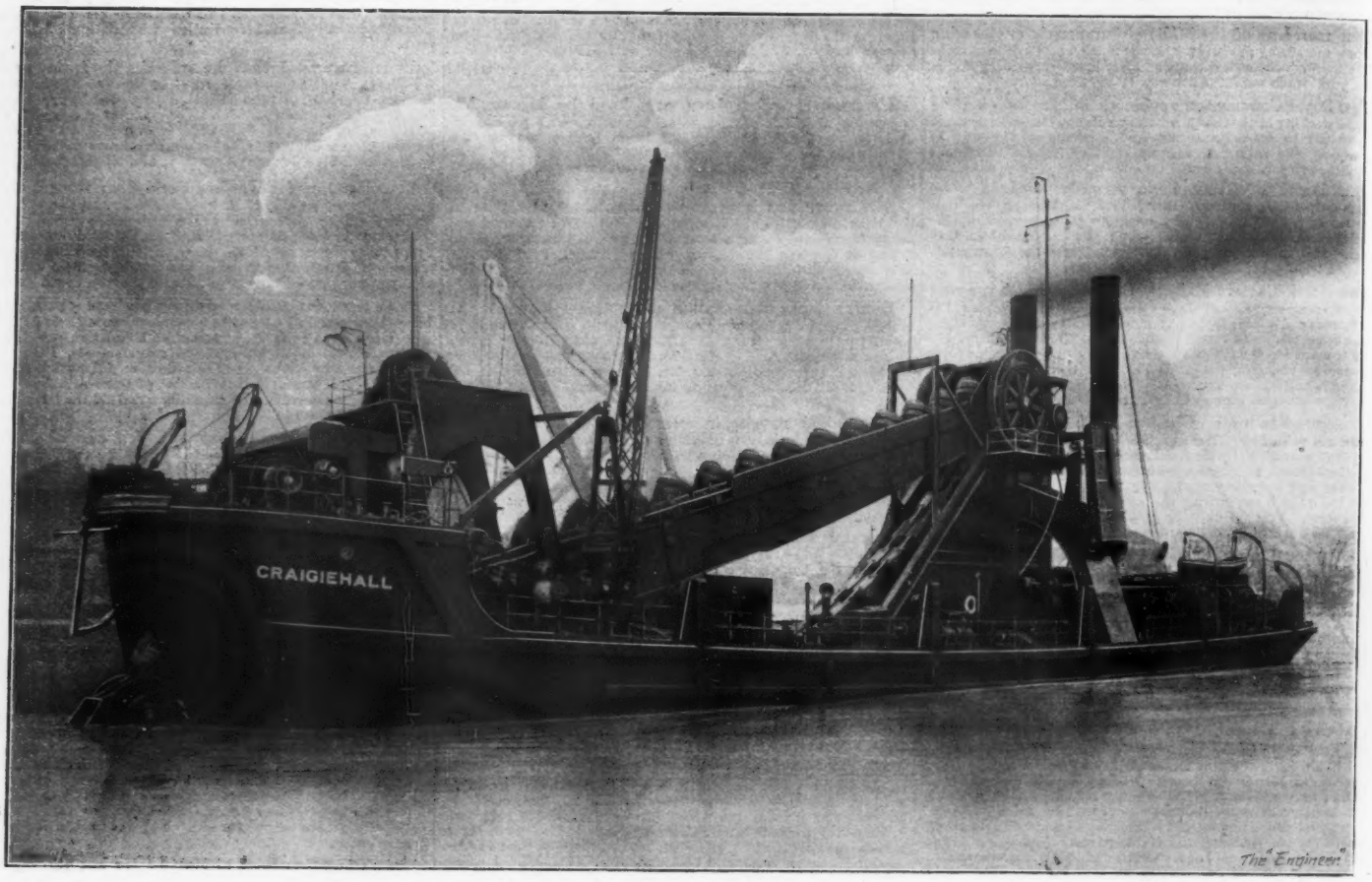
A MEMORANDUM prepared by the Labour Department of the Board of Trade for the *Labour Gazette* states that employment in November on the whole shows no material change as compared with October. As compared with a year ago, a general falling off is shown, and the percentage of unemployed trade union members continues higher than the mean percentage for the corresponding month in the past ten years. In the 228 trade unions, with an aggregate membership of 562,954, making returns, 33,614, or 6 per cent., were reported as unemployed at the end of November, as compared with 5·8 per cent. in October, and with 4·8 per cent. in the 224 trade unions, with a membership of 549,197, from which returns were received for November, 1902.

IN view of the controversy in the United States Board of Construction respecting the speed of the two new 13,000-ton battleships for which tenders have been submitted the Department will rigidly enforce the specifications in this regard. If the speed falls below 17 knots and exceeds 16¼ knots an hour, the vessels will be accepted, so far as speed is concerned, at a reduced price, the reduction being at the rate of 50,000 dols. a ¼ knot deficiency of speed from 17 to 16¾ knots, and at the rate of 100,000 dols. a ¼ knot deficiency of speed from 16¾ to 16¼ knots. If the speed falls belows 16¼ knots an hour the vessels will, at the discretion of the Secretary of the Navy, be rejected or accepted at a reduced price to be agreed upon by the Secretary and the contractor. In case of rejection, any money that may have been paid the contractor on account shall be refunded.

THE NEW CLYDE DREDGER CRAIGIEHALL

WILLIAM SIMONS AND CO., LIMITED, RENFREW, ENGINEERS

(*For description see page 595*)



THE DREDGER AT WORK

THE DREDGER ON THE STOCKS

FOREIGN AGENTS FOR SALE OF THE ENGINEER.

AUSTRIA.—F. A. BROCKHAUS, *7, Kumpfgasse, Vienna I.*
CHINA.—KELLY AND WALSH, LIMITED, *Shanghai and Hong Kong.*
FRANCE.—BOYVEAU AND CHEVILLET, *Rue de la Banque, Paris*
GERMANY.—ASHER AND CO., *13, Unter den Linden, Berlin.*
F. A. BROCKHAUS, *Leipsic*; A. TWIETMEYER, *Leipsic.*
INDIA.—A. J. COMBRIDGE AND CO., *Railway Bookstalls, Bombay.*
ITALY.—LOESCHER AND CO., *307, Corso, Rome*; BOCCA FRERES, *Turin.*
JAPAN.—KELLY AND WALSH, LIMITED, *Yokohama.*
Z. P. MARUYA AND CO., *14, Nihonbashi Tori Sanchome, Tokyo.*
RUSSIA.—C. RICKER, *14, Nevsky Prospect, St. Petersburg.*
S. AFRICA.—WM. DAWSON & SONS, LIMITED, *7 Sea-st. (Box 139), Capetown.*
GORDON AND GOTCH, *Long-street, Capetown.*
R. A. THOMPSON AND CO., *33, Loop-street, Capetown.*
J. C. JUTA AND CO., *Capetown, Port Elizabeth, Johannesburg, East London, Grahamstown, King Williamstown, Stellenbosch.*
HANDEL HOUSE, LIMITED, *Kimberley.*
ADAMS AND CO., *Durban and Maritzburg.*
AUSTRALIA.—GORDON AND GOTCH, *Melbourne, Sydney, and Brisbane.*
R. A. THOMPSON AND CO., *180, Pitt-street, Sydney*; *Melbourne Adelaide, and Brisbane.*
TURNER AND HENDERSON, *Hunt-street, Sydney.*
NEW ZEALAND.—UPTON AND CO., *Auckland*; CRAIG, J. W., *Napier.*
CANADA.—MONTREAL NEWS CO., *386 and 388, St. James-street, Montreal.*
TORONTO NEWS CO., *42, Yonge-street, Toronto.*
UNITED STATES OF AMERICA.—INTERNATIONAL NEWS CO., *83 and 85, Duane-street, New York*; SUBSCRIPTION NEWS CO., *Chicago.*
STRAITS SETTLEMENTS.—KELLY AND WALSH, LIMITED, *Singapore.*
CEYLON.—WIJAYARTNA AND CO., *Colombo.*

SUBSCRIPTIONS.

THE ENGINEER can be had, by order, from any newsagent in town or country, at the various railway stations; or it can, if preferred, be supplied direct from the office on the following terms (paid in advance):—

Half-yearly (including double number) .. .. £0 14s. 6d.
Yearly (including two double numbers).. .. £1 9s. 0d.

CLOTH READING CASES, to hold six issues, 2s. 6d. each, post free 2s. 10d.

If credit occur, an extra charge of two shillings and sixpence per annum will be made.

Foreign Subscriptions will, until further notice, be received at the rates given below. Foreign Subscribers paying in advance at these rates will receive THE ENGINEER weekly and post free. Subscriptions sent by Post-office Order must be made payable to THE ENGINEER, and accompanied by letter of advice to the Publisher.

THIN PAPER COPIES.		THICK PAPER COPIES.	
Half-yearly	£0 18s. 0d.	Half-yearly	£1 0s. 3d.
Yearly	£1 16s. 0d.	Yearly	£2 0s. 6d.

(The difference to cover extra postage.)

ADVERTISEMENTS.

☞ The charge for advertisements of four lines and under is three shillings, for every two lines afterwards one shilling and sixpence; odd lines are charged one shilling. The line averages seven words. When an advertisement measures an inch or more, the charge is 10s. per inch. All single advertisements from the country must be accompanied by a Post-office Order in payment. Alternate advertisements will be inserted with all practical regularity, but regularity cannot be guaranteed in any such case. All except weekly advertisements are taken subject to this condition.

Advertisements cannot be inserted unless delivered before Six o'clock on Thursday evening; and, in consequence of the necessity for going to press early with a portion of the edition, ALTERATIONS to standing advertisements should arrive not later than Ten o'clock on Tuesday morning in each week.

Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

Telegraphic Address, "ENGINEER NEWSPAPER, LONDON."

PUBLISHER'S NOTICES.

***** During the rebuilding of the house, No. 33, Norfolk-street, "THE ENGINEER" will be edited and published in Temporary Offices, Nos. 2 and 3, Norfolk-street, to which all communications for the Editor or Publisher should be addressed.**

*** *Next week* THE ENGINEER *will be published on* WEDNESDAY, *instead of* FRIDAY. *New Advertisements should reach the Office not later than Six o'clock on Tuesday evening; alterations to Standing Advertisements before One o'clock on Monday afternoon.*

*** *If any subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

CONTENTS.

THE ENGINEER, 18th December, 1903.

	PAGE
NEW FORMS OF STEAM TURBINE. No 1.	587
THE LIMITS OF WORKING STRESS IN BRIDGES. No. IV.	588
OUR MINERAL STATISTICS	589
TREVITHICK'S LOCOMOTIVE EXPERIMENT IN 1808	589
COMPOUND LOCOMOTIVES. CANADIAN PACIFIC RAILWAY. (Illustrated.)	590
THE PROGRESS OF THE SIMPLON TUNNEL	590
LITERATURE	592
MOTOR CARS IN PARIS. (Illustrated.)	593
BOOKS RECEIVED	593
ELECTRICALLY-DRIVEN WELL PUMPS	594
DREDGING PLANT AND CLYDE IMPROVEMENT	595
THE AUTOMOBILE CLUB'S RELIABILITY TRIALS	596
AMERICAN ENGINEERING NEWS	596
LAUNCHES AND TRIAL TRIPS	596
NOTES AND MEMORANDA—MISCELLANEA—RAILWAY MATTERS	597
LEADING ARTICLES—Electric Lighting in Marylebone	599
Electrical Combinations in Germany—The Limitations of Mechanism	600
MILITARY TRACTOR. (Illustrated.)	601
STEAM OMNIBUSES FOR TORQUAY. (Illustrated.)	602
DOCKYARD NOTES	602
PORTABLE GAUGE TESTER. (Illustrated).	603
REMOVABLE VALVE SEAT. (Illustrated.)	603
A MINERS' SAFETY-LAMP TESTER. (Illustrated).	603
ANGLE CROPPER. (Illustrated.)	604
CATALOGUES	604
STEAM TRAPS	604
LETTERS TO THE EDITOR—Steam Turbo Generating Plant.. Steam Turbines—Lathe of the Future—Breakdowns in the Navy—Suburban Railway Traffic—The Conservation of Energy—The Motor Car in Private Life—Trade Marks in Japan—Rats and Electric Wires	604 605 606
THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS	603
NOTES FROM LANCASHIRE	606
THE SHEFFIELD DISTRICT	607
NORTH OF ENGLAND	607
NOTES FROM SCOTLAND	608
WALES AND ADJOINING COUNTIES	608
NOTES FROM GERMANY	608
AMERICAN NOTES	608
THE PATENT JOURNAL	609
SELECTED AMERICAN PATENTS. (Illustrated.)	610

TO CORRESPONDENTS.

☞ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

☞ *All letters intended for insertion in* THE ENGINEER, *or containing questions, should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

☞ *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

REPLIES.

BUILDER.—See Freitag's "Architectural Engineering," published by Chapman and Hall.

G. W. J.—Anybody who likes may put C.E. after his name. It has no particular significance.

J. I. (Bolton).—Write to Verlag von Julius Springer, Berlin, for a copy of list of technical works. Get a copy of Mach's "Science of Mechanics" in the original. You might get Conrad Matschoss's "Geschichte der Dampfmaschine," or Pauer's "Berechnung u. Konstruktion der Schiffsmaschinen," published by Oldenburg, Berlin.

R. F. P. (Winchmore Hill).—You will have great difficulty in getting to sea at your age. It is true that the Board of Trade will grant certificates to men who have not been through the shops, taking extended service in an engine-room at sea as an equivalent, but you would find yourself heavily handicapped, and you could only go to sea in the first instance by favour of some shipowner with whom you had interest.

A. BETA.—There is some diversity of opinion, but general practice appears to be to make the air pipe rather less than half the diameter of the rising main. Possibly if the thickness of the air pipe is taken into account it will be found to be exactly 2 : 1. At Tunbridge Wells the ratio is higher, exactly 7in. to 2½ (see Maxwell's paper in our issue of August 14th). The pump at Hyde Park-court Mansions (THE ENGINEER, August 2nd, 1901) has a 7½in. rising main with a 3in. air pipe in a 24in. bore. In an earlier installation the pipes were 3in. and 5in. pipes, the annulus being used for the air (THE ENGINEER, April 28th, 1899). The well is 10in. diameter. We do not know of any text-book that deals with the question at all fully.

ONE INTERESTED (Bombay).—Motor car engines are single-acting; most of them work on the Otto cycle, that is the crank gets an impulse only every alternate revolution. By using two cylinders it may receive an impulse every revolution. The turning action is therefore more regular. By multiplying the number of cylinders quite a regular turning force or torque may be obtained. That is the main point. Distributing the load over several cylinders is found to be better in other respects as well. Try to climb a long stiff hill on a one-cylinder car and you will find out why, and at once want a car with two cylinders. You are wrong in thinking English makers are exceptional in using many cylinders. Six cylinders have been put into Mors cars. The disadvantage of two or more cylinders is more than balanced by the advantages up to a certain point.

INQUIRIES.

ROBBINS' BELT CONVEYOR.

SIR,—I shall be obliged to any reader who will give me the address of makers of Robbins' conveyor.

Queen Victoria-street, December 16th. P.

MEETING NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, December 22nd, at 8 p.m. Ordinary meeting. Paper, "On the Resistance of Plane Surfaces in a Uniform Current of Air," by Mr. Thomas Ernest Stanton.

THE ENGINEER.

DECEMBER 18, 1903.

ELECTRIC LIGHTING IN ST. MARYLEBONE.

EVENTS which occurred last week serve to show that the difficulties which beset the Borough Council of St. Marylebone in connection with the purchase of that part of the undertaking of the Metropolitan Supply Company which lies within their district are increasing rather than diminishing. An article appeared in the *Times* of December 10th which gives the public an opportunity of understanding the facts of the case, and it is therefore unnecessary for us to state them at length. Suffice it that the Council are bound, under a statutory contract, to purchase the undertaking for a sum of £1,212,000. Upon an application to the London County Council for the necessary funds, that body declined to make any advance, and the Local Government Board and the Board of Trade both refused to interfere. In the meantime, however, the company applied to the High Court for a decree of specific performance of the contract, as a result of which the Borough Council have been ordered to pay the full amount by December 31st, 1903, subject, nevertheless, to their being allowed to make application for further time. An application was duly made last week, when Mr. Justice Buckley granted an extension, subject to an interim payment of £60,000 to enable the company to carry on the supply for the present. In granting the extension, the learned judge was influenced by the fact that an order for immediate payment would be a hardship to the ratepayers, and also by a statement that the Council were about to apply to Parliament for a special Act under which to raise the loan. Let us see exactly what this purchase will mean to the ratepayers of St. Marylebone, the majority of whom are in comparatively poor circumstances. It is estimated that the total sum which the Council will have to find will be £2,000,000, inclusive of a site for a new generating station. Of this sum £1,000,000 represents the goodwill of the undertaking. If Parliament, in granting the loan, allow twenty-seven years for its repayment, it is estimated that, allowing for interest at 4 per cent. and the necessary sinking fund, an income of £105,800 will be required. Where is this to come from? The actual net profits of the electric light undertaking in the hands of the company for 1901 and 1902 were £50,000; but it is alleged that the average net annual profits for the years 1901-1931 will be £55,000, inasmuch as it is said there is some prospect of an increase in profits. But even assuming that this large profit will be earned, from what source is the balance of £50,800 to come? As far as we can see, it can only come out of the rates. In these circumstances it is not surprising that a petition signed by a large number of ratepayers should have been presented to the Borough Council on December 10th, urging that some endeavour should be made to cancel the contract and make terms with the company. As soon as the deputation which supported the petition withdrew, it was moved in the Council "that the seal of the Council be affixed to the petition to Parliament for leave to introduce the St. Marylebone Electric Lighting Bill, 1904," and this resolution was carried by forty-one votes against seventeen. Subsequently, however, a committee was appointed for the purpose of approaching the company, in order to ascertain whether any arrangement can be made to remove the present deadlock.

This is the outline of the case, and it is exceedingly difficult to foretell what the ultimate result of the matter will be. One thing, however, is abundantly clear—the ratepayers of St. Marylebone stand to lose. If the negotiations with the company break down, it is obvious that the Council must go to Parliament for the necessary borrowing powers. If these powers are conferred, the ratepayers will be heavily mulcted for many years to come. If Parliament, in response to the urgent appeal of the ratepayers, refuses to sanction the loan, the Council will be at the mercy of the company, who, in accordance with the existing law, will be able to enforce specific performance of the contract by sequestration of the rates, or other means. Lastly, if a compromise is arrived at, it will be "heads I win, tails you lose," for the company, inasmuch as all the costs thrown away, and in all probability a substantial sum for compensation, will have to be paid by the Council. We might mention, in passing, that the costs of, and incidental to, the arbitration proceedings alone came to about £70,000. Even if a special Act is obtained annulling the whole sale, it would be impossible for Parliament to deprive the company of costs and expenses, and a reasonable sum for compensation.

Altogether the situation is one of the greatest interest, not only to the unfortunate ratepayers of St. Marylebone, but to students of municipal trading in every part of the kingdom. The facts which have come out show with what a light heart the so-called representatives of the ratepayers incur liability. One set of figures alone will prove how reckless they can be. The company estimated the discounted value of their profits—*i.e.*, the value of their goodwill—between 1901 and 1931 at £2,500,000; the St. Marylebone Borough Council estimated these profits at about £400,000; while the arbitrator, whose award is now sought to be enforced, allowed £1,000,000. Presumably it was with the hope of acquiring the goodwill for £400,000 or thereabouts that the Council obtained the necessary parliamentary powers for compulsory purchase. Instead of this, they are ordered to pay no less than £1,000,000, by an arbitrator who was appointed to adjudicate by a statute which they themselves had had placed upon the book.

We have no doubt whatever that the Council acted *bonâ fide* in what they considered the best interests of their constituents. They thought, beyond question, that this net profit of £50,000 should not be filling the pockets of shareholders in a private company, but that it should come to them to be used by them in relief of the rates. If in attempting to turn this Utopian dream into reality they have sustained a defeat, they have at least done enormous service in turning public attention to some of the evils of municipal trading. Of course, the circumstances were exceptional; and the compulsory sales of electrical undertakings to local authorities, which may take place in accordance with the provisions of the Electric Lighting Acts, do not involve payment of anything for "goodwill." But the lesson of the St. Marylebone case will not be forgotten when purchases are effected in accordance with the provisions of the Electric Lighting Act, 1888, Sec. 2. That enactment provides that after the lapse of a certain period a local authority may purchase an electrical undertaking "upon terms of paying the then value of all lands, buildings, works, materials, and plant of the undertakers—meaning the company—suitable to and used by them for the purposes of their undertaking. The value of such lands, &c., are to be deemed to be their fair market value at the time of the purchase, due regard being had to the nature and the condition of such buildings, works, materials, and plant, and to the state

of repairs thereof, and to the circumstance that they are in such a position as to be ready for immediate working, and to the suitability of the same to the purposes of the undertaking, and where a part only of the undertaking is purchased, to any loss occasioned by severance; but without any addition in respect of compulsory purchase or of goodwill or of any profits which may or might have been made from the undertaking or of any similar considerations." In the case we are dealing with, the St. Marylebone Borough Council enormously under-estimated the value of goodwill. It is possible that local authorities desirous of exercising powers of compulsory purchase in time to come may hesitate before they commit their ratepayers to a purchase of plant, &c., which may be valued in arbitration proceedings at a much higher figure than they imagine.

ELECTRICAL COMBINATIONS IN GERMANY.

The extraordinary movement which is taking place in the German electrical engineering industry cannot fail to be of considerable interest to British firms, whether they are or are not engaged in the export as well as the home trade, seeing that the competition of the former has to be met both in the United Kingdom and in external markets, and because this rivalry promises to become largely accentuated in the near future. This movement, which aims at the gradual consolidation of the industry in the form of a few powerful groups, is of comparatively recent growth. Exactly a year ago a report was circulated to the effect that a combination or trust of the six principal manufacturing companies was in process of formation, but the rumour was immediately contradicted, and although a trust on American lines may be said to be out of the question at the present time, a formidable scheme of consolidation has been planned, and is being continued in such a manner as to render it difficult to predict what shape it will eventually assume. The magnitude of the German electrical industry, from a financial standpoint, will be understood from the fact that, in round figures, the twelve leading concerns, both manufacturing and their investment, or so-called trust companies, represent a share capital of £20,000,000 sterling, and a bonded capital of £12,000,000. Apart from this, four of the works which have now been merged into two groups, which alone claim to share three-fourths of the total electrical trade of the country, have the financial support of the leading banking institutions in Germany. For instance, one group is backed by the Berlin Handels Gesellschaft, the Disconto Gesellschaft, the Darmstadt Bank, the Schaaffhausen Bank Verein, the Dresden Bank, and others, while the syndicate supporting the second group comprises the Deutsche Bank, the Central German Credit Bank, the Bavarian Mortgage and Exchange Bank, the Bavarian Vereins Bank, and the Commerce and Discount Bank. All these institutions assist in the floatation of schemes, or the placing of shares of undertakings which are promoted by the manufacturing companies in conjunction with their so-called financial trusts.

It has already been stated that the consolidation movement has only recently been started. It commenced last April, and has accomplished wonders in the few months which have elapsed. It was begun by the establishment of a community of interests between the Allgemeine Elektricitats Gesellschaft and the Union Electricity Company, which controls the Thomson-Houston patents in Germany and certain other European countries, exclusive of France. This arrangement, which has been entered into for a period of thirty-five years, and the details of which it will be unnecessary to mention, provides for a pooling of the profits of the two companies and the centralisation of manufacturing operations in such a way as largely to decrease the cost of production. A complete fusion of the two concerns would, however, not be a surprising announcement at any moment, although such a state of affairs may be said to exist already for all practical purposes of manufacturing and trading. This combination, which represents a total share capital of £4,200,000, was shortly afterwards followed by the amalgamation of the heavy electrical engineering branches of the Siemens and Halske Company and the works and plant of the Schuckert Electrical Company, under the title of the Siemens-Schuckert Works Company, with a share capital of £4,500,000. The consolidation which has thus been effected differs somewhat from that of the Allgemeine and the Union Companies, inasmuch as the Siemens and Halske Company has retained its light electrical engineering departments, while the original Schuckert Company continues in existence for the purpose of its financial interests and undertakings and its relations with the Continental Company for Electrical Enterprises of Nuremberg. The two groups formed in this manner are those which are said to control three-fourths of the electrical trade of Germany, and which are financially supported by the banking institutions previously mentioned. It is calculated that the four concerns constituting the two groups have in the past expended £600,000 in the elaboration of schemes and plans for lighting and traction undertakings, and by the reduction in competition that has been brought about by the amalgamation this expenditure will henceforth be very considerably lessened, with advantage to the groups. In addition to these combinations, the Berlin Accumulator—Tudor—Company is at the present moment absorbing the Pollak Accumulator Company, of Frankfort-on-the-Main; the Bitterfeld and Rheinfelden Electrochemical Companies are about to amalgamate, and the Berlin Electric Light and Power Investment Company is taking over the undertaking of the Cologne Company for Electrical Investments, which will combine a share capital of £2,300,000, while the Lahmeyer and the Helios Electrical Companies, with a joint capital of £2,000,000, are reported to be on the point of establishing either a friendly arrangement or proceeding in the direction of a fusion.

It will be obvious that extraordinary is a mild term to apply to the movement that is now being promoted in Germany. Here we have combinations already formed, and others in progress, for the purpose of reducing expenses and cheapening the cost of production, and this object is facilitated by concentration and specialisation of manufacture. For instance, if any particular department or departments of one of the amalgamated firms is equipped for turning out finished goods more cheaply than the similar branches of its partner, the latter are shut down, and entire attention is devoted to those which show the best financial results. This is specially the case in regard to the two leading groups, which have, moreover, now begun to co-operate in a friendly manner in respect of foreign undertakings, as, for instance, in Mexico and at Valparaiso. This movement may be expected to extend, and competition with British works in home and external markets must necessarily become more acute. There is certainly no need for alarm on the part of British firms, but they will in future have to make preparations for meeting exceedingly severe rivalry of the German combinations, assisted as they are by the principal banks in the country.

THE LIMITATIONS OF MECHANISM.

Most of us have at times been disposed to say that all things mechanical were possible to mechanism. When we see a bit of gold wire automatically converted into a dainty little chain for a lady's neck; a Jacquard ribbon loom weaving pictures and picking out thread and shuttles with a discrimination all but human; or a pattern lathe reproducing spokes or gun stocks of complex shapes apparently without the aid of man or boy, the belief that mechanism can do everything but speak—and even the phonograph does that—seems to spring up in our minds as the obvious result of observation of things as they are. No doubt this conviction, this blind faith—for it is blind—in metal in motion has led to the waste of an enormous amount of ingenuity, time, and money in the search for the impossible. Mechanism has its limitations; what they are, in part at least, we propose to consider here.

In the first place, then, it may be admitted that the operation of all mechanism consists in movements in certain fixed directions; but these movements can be so varied in their dimensions, and so co-ordinated, that the movements and their combinations appear to comply with every possible condition of production. Thus, to take the case of the Jacquard loom. It is a familar fact that its principle of action involves the lifting of certain threads in the work so that the shuttle passes under instead of over them. The first operation, then, is the vertical lifting and dropping of threads about their mid-length, their two ends being secured. The second operation is the throwing of the shuttle backwards and forwards. For pattern weaving in colours several shuttles are used, and these are selected by the Jacquard cards, each shuttle carrying a thread of a different colour. All these operations follow each other in regular order, and so the pattern is repeated all along the piece of ribbon, or silk, or cotton in the loom. After all, the whole thing is very simple. The complication lies not in the movement of the loom, but of the number of parts to be moved. So long as the same operations are done in the same order, so long will the loom continue to turn out the required pattern. The same truth holds good of a great many other operations carried out by automatic machinery; and if nothing more than this is required, then there is no physical limit to the possibilities of mechanism. The moment, however, that we try to go beyond this, and endow our machinery with the power of discrimination, we are brought up against a stone wall. There are apparent exceptions. Thus, for instance, a power loom has discrimination enough to stop the moment a thread breaks; or, what is more to the point as an illustration, the gold coin weighing machinery at the Mint will pick out with the most unerring accuracy, a light coin, and will drop it into its own receptacle. But even here there is no approach whatever, except in semblance, to the working of a mental process. No machine has been invented, or can be invented, which will detect split coins. That is done by boys, who sound the coins on a small anvil with a marvellous celerity and certitude born of long practice. The boys have ears; no machine can be made with ears. Hence the detection of split coins is beyond the power of mechanism.

But the impassable gulf between intelligence and mechanism is that the machine has no past and no future, only an instantaneous, ever-shifting present. It cannot draw deductions as to future conduct from the recollection of past events. It is said that we should never prophesy unless we know. Yet every action of our lives, almost without exception, is due to the possession of that prophetical sense which comes of the projection of the past into the future. We enter a train, and know that it will carry us to our journey's end. We can foretell to a minute the hour at which we will arrive, and so on. Through the multifarious operations of daily life we trust that in the future events will shape themselves precisely as they have done in the past. The results of the gift of prescience are all powerful. They define the course of human life at every turn. But the machine has, as we have said, no past and no future. Nothing that has happened to it in the past can make it do that in the future which it has not done before. Of course, we are not now speaking of changes in construction or mode of action introduced from outside by accident or design. Mechanism cannot anticipate; and in this fact lies an all-important limitation against which inventors have struggled without success ever since invention began.

A potent example of this is supplied by the governing of steam engines. In certain manufactures—as, for example, the spinning of the higher numbers of cotton yarns—it is essential to success that the engine driving the mill shall run at a perfectly steady velocity—that is to say, in other words the "governing must be close." No governor can be invented which will anticipate—in other words, before the governor can act to give more steam or less steam the engine must have either fallen off or gained in speed. All that the governor can do is—the change having taken place—restore the engine to its normal speed as quickly as possible. But even this the ordinary governor alone cannot do. The engine runs, we shall suppose, too slowly; the governor opens the throttle valve, or its equivalent, and gives more steam. The engine then returns to its normal speed, but so does the governor, and reduces the steam supply. The limits of mechanism come into play. If a man controlled the engine he would give a little more steam than before, and the engine would retain its proper speed. As a way of mitigating the evil, a subsidiary governor is used which alters the length of the rod coupling the governor balls to the cut-off gear or throttle valve. But do what we may, the fact remains that the controlling mechanism, being unable to anticipate, is also unable to prevent a change in the velocity with which the crank shaft turns round.

The fact that mechanism cannot anticipate has prevented the substitution of a governor for the engineer at the throttle valve of a marine engine racing in a seaway. Such a governor should shut off steam the moment the stern begins to lift, and, of course, before the screw is out of the water; and it should turn steam on again the moment the stern begins to descend. Hitherto nothing has been produced that does more than approximate to a condition which is the more difficult of fulfilment, that in a triple-expansion engine there is always quite steam enough in it to produce dangerous racing after the throttle valve is shut, and empty space enough to prevent the screw from starting quickly when steam is turned on again. The greater the prophetical period, the more hopeless does the expectation become that the governor will manifest semi-human intelligence.

It is said that Babbage, inventing his calculating machine, always had it in mind that it was possible to produce mechanism which could jump to conclusions, and give, for example, a series of logarithms of numbers without calculating them out. Most inventors of automatic mechanism wish with all their hearts that it was possible to get a machine which, even in a very small way, would jump to conclusions. To the end of time, however, it seems

to be certain that particular operations can only be carried on by human intelligence. In some cases human labour is cheaper than any machine that can be suggested to take its place; while in others it is impossible to see how work can be carried to a successful end by any combination of mechanism. Startlingly ingenious as some machines are, we never find them able to dispense in the long run with human brains, or take the place of the ubiquitous human hand. The biscuit-boxes, for example, made of tin-plate, with which we are all so familiar, are made by automatic mechanism which cuts them out of the sheets, makes the holes and the tongues that go into them, folds the box to shape, puts the tongues into the holes, and bends them over. But this marvellous mechanism cannot get on without supervision. It could not detect a flaw in a sheet of tin or a deficiency in size. If the tongue did not go right through the hole it would bend it over all the same, and so on to the end. That inventor will be prudent who fully masters and perfectly understands, not what things mechanism can do and cannot do—because it can do anything, only it will not necessarily do it at the right time or in the proper sequence—but what is the part that must unavoidably be played by the human element in producing the required end. There never can be a universal substitute for the most wonderful bit of mechanism the world has seen—the human hand.

MILITARY TRACTOR.

IN our last issue we briefly announced the fact that the first prize of £1000 for a military tractor had been awarded by the War-office to Richard Hornsby and Sons, Limited, of Grantham, who had also secured bonuses amounting to £180. The engine which has secured this prize is illustrated above, and a general description of it is given below. Let us first, however, recall a few of the conditions laid down by the War-office, that the task the tractor succeeded in accomplishing may be fully appreciated.

The weight of the tractor was not to exceed 13 tons when fully loaded and ready for the road. In that condition, and without any replenishment on the road, it was to haul a load of 25 tons for not less than 40 miles, at between three and five miles an hour on ordinary roads with a maximum gradient of 1 in 18, whilst it was to be able to make a spurt at eight miles an hour for one mile on a level road hauling 12½ tons; and, furthermore, it was to be capable on occasion of pulling a similar load up a gradient of 1 in 6. Of course, it had to be strong enough to stand the ordinary knocks and buffets of a campaign, but it was further expected to cross a ford 2ft. deep without upsetting its motive power. It had to go backwards or forwards, to be content with the attendance of two men, to be dust proof, to have winding gear, and not to exceed 9ft. high, inclusive of removable parts, by 7ft. 4in. wide. It might be 20ft. long. There were a lot of other conditions that had to be observed by steam-propelled engines, with which we need not deal.

On the following points the judges laid special stress:—The total distance that a load of 25 tons could be hauled at three miles an hour without re-charging in any way; the price; the economy in working and maintenance; ease of manipulation; simplicity of design; absence of noise, smell, &c.; the prevention of damage by dust; and the capability of using fuel of varying description and quality.

Having outlined what was expected of the tractor, let us turn to our description of the only prize-winner. This, as sent to the War-office, is substantially as follows. We may add that the total weight of the tractor in running condition was 13 tons, of which about 10 cwt. was accounted for by oil, water, &c:—

The tractor is mounted on four ordinary type traction engine wheels, and propelled by a Hornsby-Akroyd oil engine having two cylinders, each 13in. diameter by 18in. stroke, arranged side by side and one above the other, the lower one being horizontal and the upper one inclined, so that its longitudinal axis passes through the centre of the crank shaft. The connecting-rods of both pistons are connected to a common crank pin side by side. The crank shaft makes 350 revolutions per minute, and is fitted with a forged steel disc fly-wheel, 4ft. 3in. diameter by 4in. wide.

The engine is constructed with the working cylinders open at one end to receive the pistons and closed at the other, except for necks connecting them with the vaporisers. The connecting-rods are attached at one end to the inside of the pistons, and at the other to the crank pin, near to the cylinder back ends; valve-boxes are fitted, each containing two valves, one being the air valve and the other the exhaust valve. These valves are mechanically opened by separate levers, each lever being moved by a cam mounted on a horizontal shaft driven through skew gearing by the crank shaft.

At the end of each cylinder is the vaporiser, which is a metal box made in two parts, one called the cold part—being water jacketed—and the other the hot part. The vaporiser is open to the cylinder through the neck before named. To enable the vaporisers to vaporise and ignite the oil pumped into them, the hot parts, at starting, are heated by external lamps; and when the engine has started these lamps are no longer required, the requisite heat being maintained by the internal explosions.

There are three oil tanks, made of tinned sheet iron, having a total capacity of 111 gallons. These tanks are arranged between the frame under the crank shaft and cylinders, and are filled by hand through a filter fitted with a strainer. The oil is drawn from the tanks by two small oil pumps—one for each vaporiser—and, during the out-stroke of the pistons, when, they are drawing in air—forced into the vaporiser. On its way the oil passes through two vaporiser valve-boxes, each valve-box having two valves, one of which admits the oil to the vaporiser, the other being opened by the governor—whenever the engine is running too quickly—so as to allow some of the oil to flow back by the waste pipe into the tank. The engine works on what is known as the "Otto" four-cycle

MILITARY TRACTOR

RICHARD HORNSBY AND SONS, LIMITED, GRANTHAM, ENGINEERS

plan, the series of operations being completed by every two revolutions of the crank.

The lamps for heating the vaporiser are of the coil type, the coils being fixed inside a chimney, at the bottom of which is attached an oil cup, and the coil is attached by a three-way cock to a reservoir, to which is fitted a hand air-charging pump. They make the vaporisers sufficiently hot in about twenty minutes.

The engine is started by a compressed air and gas self-starter, the compressed air and gas being stored in a welded steel receiver arranged on the right-hand side of the engine, nearly under the fly-wheel. This is connected up to the lower cylinder only through a valve-box containing two valves—one for admitting the compressed air and gas, and which is actuated by a hand lever; the other is a check valve to prevent the starting ignition or explosion striking back into the receiver.

To start the engine—the vaporisers having been previously heated and a charge of oil pumped into them—the crank is placed slightly above the dead centre on the forward or explosion stroke of the lower cylinder. The starting valve is then quickly opened and closed, which causes an explosion in the lower cylinder, and starts the engine. Suitable shut-off valves are fitted on the reservoir, and a small valve-box with two valves for automatically charging it by admitting a portion of the gases of explosion at each working stroke. A geared fly-wheel hand-charging pump is fixed beneath the footplate on the right-hand side, to enable the reservoir to be charged should the pressure be allowed to run down.

The oil pumps are of solid gun-metal, and are fitted with double sets of suction and delivery valves, and are actuated by the air lever. The stroke of the pump is regulated to suit the load on the engine by quadrants actuated from the footplate by a hand lever. The engine is also stopped and the charge of oil pumped into the vaporiser at starting by this hand lever.

The speed of the engine is regulated by a spring governor opening the vertical valve in the vaporiser valve-boxes and returning the excess oil to the tanks. The governor is arranged to be put out of action for the purpose of racing the engine when starting or when extra power is required for short periods by a lever actuated from the footplate.

The cylinders are water-jacketed, and the water is circulated by a rotary pump round them and through a cooler under the footplate. The cooler is of the "Clarkson Capel" type, consisting of a series of brass tubes with spiral wire bound round the outside. The ends of the tubes are connected to aluminium headers. The water passes through the tubes, and air is drawn over the outside of the tubes by a "Sirocco" fan arranged under the footplate behind the cooler. The air is drawn through the frame in front of the rear axle. The fan is driven by a longitudinal shaft by bevel gears from a cross shaft under the crank shaft. The cross shaft and rotary circulating pump are driven by a train of spur gears from the crank shaft.

A water column is arranged on the top of frame to provide for the expansion of the hot water. It is also fitted with a condensing coil to reduce loss by evaporation to a minimum.

To protect the cooler and fan from injury—should the engine sink in soft ground—flanged steel plates are fitted below them of suitable strength to support the weight of the engine.

Air inlet.—The air is drawn from a silencing-box formed in the upper part of the frame between the crank shaft and cylinders, and consists of a box perforated at one end. Inside the box are arranged the ends of the air pipes, which have a long, narrow slot formed in them.

Exhaust silencers.—The main exhaust silencer consists of a box formed in the front end of the frame, into which the exhaust pipes from the engine cylinders are led. A chimney is placed at the top of this box, and is constructed to form a second silencer, it having an inner tube slightly smaller in diameter with a dead end at the top. The exhaust from the main silencer is led by a pipe to the top of the inner tube, which it descends and then passes upwards through the annular space formed by the inner tube and chimney to the atmosphere.

Oil fuel.—The engine, as fitted, is suitable for using refined Russian oil, but by having two additional cap ends for the vaporisers and adjusting the compression—means for which are provided on the small ends of the connecting-rods—by changing the position of the steel compression plates, either refined American, Scotch shale, crude Russian, Astatki, Texas liquid fuel, and Burmah oils can be used. The engines when using crude oils would give off about 10 per cent. less power and the vaporisers would require cleaning out every twelve hours. This can readily be done by a scraper through doors provided in the cap ends.

The propelling gear is started and stopped by a friction clutch attached to the pinion on the oil engine crank shaft. The reversing is effected by bevel gears and a clutch on the first motion shaft, and the various changes of speeds—four in number—by sliding pinions and wheels on the second and third motion shafts.

The levers actuating the friction clutch, reversing clutch speed changing gear, oil pump stroking gear, accelerator for governor, hand wheels of brakes on hind wheels, fourth motion shaft, fly-wheel, and all lubricators are worked from the foot-plate.

The driving wheels are 7ft. diameter by 18in. wide; the front wheels 4ft. 1½in. diameter by 8in. wide.

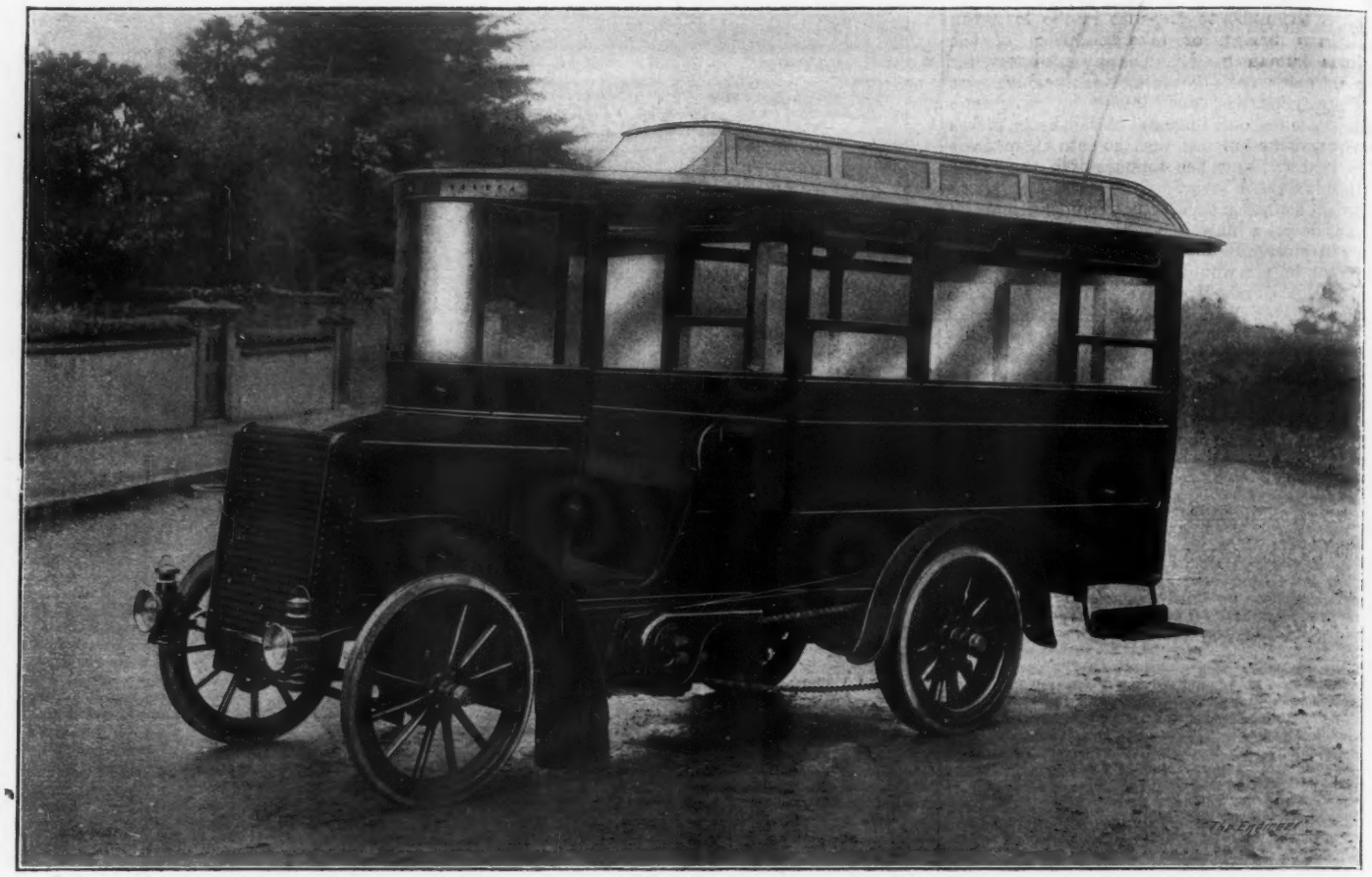
The trials took place in October and November last. They were not competitive, since the winner was the only engine tested, the stiffness of the conditions having deterred others from entering. The fact that the first prize was awarded, when smaller prizes might have been given, shows that the tractor did all that was demanded of it. As the engine went on its own legs from Aldershot, where it was tried, to Grantham and back, it has already covered, including the maker's experiments, something like 1000 miles. We are informed that it consumes on good average roads something less than 1·2 lb. per mile with its maximum load; 30 miles have been done with 3501b. Very little water is required, a gallon being enough for the same distance. The engines run at 350 revolutions per minute, and the gears give speeds of 1½, 3, 5, and 8 miles per hour.

The tractor, it must be admitted, is not lovely to look upon, but its makers are to be congratulated on having met successfully very onerous conditions.

ROYAL INSTITUTION.—The following are the lecture arrangements at the Royal Institution before Easter:—A Christmas course of lectures—illustrated by lantern slides and adapted to a juvenile auditory—on "Extinct Animals," by Professor Ray Lankester; Professor L. C. Miall, Fullerian Professor of Physiology, R.I., six lectures on "The Development and Transformations of Animals;" Mr. E. Foxwell, three lectures on "Japanese Life and Character;" Dr. E. A. Wallis Budge, two lectures on "The Doctrine of Heaven and Hell in Ancient Egypt," and "The Books of the Underworld;" Mr. G. R. M. Murray, three lectures on "The Flora of the Ocean;" Mr. A. D. Hall, three lectures on "Recent Research in Agriculture;" Professor H. L. Callendar, three lectures on "Electrical Methods of Measuring Temperature;" Mr. Sidney Lee, two lectures on "Shakespeare as Contemporaries knew him;" Mr. J. A. Fuller-Maitland, three lectures on "British Folk-Song (with vocal illustrations); Mr. W. L. Courtney, two lectures on "Comedy: Ancient and Modern;" and six lectures by the Right Hon. Lord Rayleigh on "Physics." During the season 1904 the lectures on Tuesdays and Thursdays will be delivered at five o'clock, and the Saturday lectures at three o'clock. The Friday evening meetings will begin on January 15th, when a discourse will be delivered by the Right Hon. Lord Rayleigh on "Shadows;" succeeding discourses will probably be given by the Rev. Walter Sidgreaves, Mr. D. G. Hogarth, Mr. Alfred Austin, the Dean of Westminster, Mr. H. Brereton Baker, Mr. Alexander Siemens, Professor W. Stirling, Professor F. T. Trouton, Mr. Henry Arthur Jones, Professor Dewar, and other gentlemen.

STEAM OMNIBUS

CLARKSON, LIMITED, CHELMSFORD, ENGINEERS



STEAM OMNIBUS FOR TORQUAY.

IN the extended field which is being opened out for the operation of self-propelled omnibuses, particularly as feeders for railways, it seems highly probable that the steam engine will prove a formidable rival to the internal-combustion engine. Mr. Clarkson appears to have overcome the difficulties attending the use of heavy oils for fuel, and has thereby eliminated one of the greatest obstacles to the use of steam. He also claims to be able to use his water of condensation for feeding fire-tube boilers without the usual disastrous results, and thereby increases his range of operation on a given quantity of water.

The accompanying illustration represents a steam-propelled omnibus for public service, the first of a number that has been constructed by the firm of Clarkson, Limited, of Chelmsford, for the Torquay and District Motor Omnibus Company. It is designed to carry sixteen persons, and is of the corridor type, with ample room and comfortable seating. The motive mechanism is of the makers' standard pattern, which was described in THE ENGINEER, vol. xcv., p. 261. The boiler, having 96 square feet of heating surface, has a mild steel shell 22in. diameter by 18in. long, $\frac{5}{16}$in. thick. It has no longitudinal seams, but is pressed out of the solid plate. The tubes are of weldless solid-drawn steel, $\frac{5}{16}$in. outside diameter and 20 g. thick, expanded in the top and bottom plates, and also beaded over, so that each tube forms a stay. The safety valves are set to blow off at 400 lb. pressure per square inch, and have an automatic regulator to control the burner. The burner is capable of burning any grade of paraffin oil, and is provided with a quick-starting arrangement which needs no spirit. It is automatically regulated by the steam pressure, and is self-contained. The engine is of the horizontal type, with two high-pressure double-acting cylinders, 4in. by 4in., actuated by Joy's valve gear. The piston-rods and crossheads are of forged steel. The connecting-rods are of cast steel bushed with phosphor bronze. The crank shaft is of forged steel, bored hollow and made in halves, riveted together with steel driving wheel between. The working parts are enclosed in a cast aluminium case, with removable panels and inspection hole, all dust-tight. The engine drives direct on to a bronze gear ring encircling the differential gear-box. This gear is of the spur type, and all six wheels are of phosphor bronze, cut out of the solid and working on hollow steel pins. The differential shafts are of steel, forged solid with the wheels on the inner ends; the outer ends are coned and screwed, and fitted with three keys for securing the chain sprockets. Each shaft is carried on two hard steel bearings, having large wearing surfaces, hardened and ground to fit. The two inner bearings take all end thrust. The outer bearings are fitted with an oil retainer. Each shaft carries two excentrics, which are keyed on, and fixed longitudinally by distance tubes.

For lubrication a supply of oil is carried in a well in the engine case, and the oil from all the bearings drains back into it. From the well a pump forces the oil into each of the bearings in succession by the action of Clarkson's distributor. This ensures that every bearing is properly oiled without any further attention than occasionally adding a little oil to the well. For lubricating the cylinders a positive pump contained in an aluminium reservoir is provided, and is driven by worm gearing from the engine. Altogether there are four bronze pumps, driven direct from the differential shaft, to deal with boiler feeding, return water, fuel, and lubricating oil.

The feed-water is contained in a galvanised iron tank of 24 gallons capacity, fitted with mud pocket, drain cock, filling and suction strainers. The main fuel tank, made of sheet steel, is riveted together and galvanised, and has also a capacity of 28 gallons. The fuel tank is fitted with a glass gauge and graduated scale, filling and suction strainers, and part of the top is made removable for inspection and cleansing. The pressure tank is made of seamless steel, fitted with pressure gauge, and has been tested to 200 lb. per square inch by hydraulic pressure.

Two independent brakes are provided, acting directly upon the driving wheels—a band brake, worked by a foot lever, and an internal expanding brake, worked by hand and capable of locking. Both brakes have metallic surfaces. The steering is irreversible, and operated by a wood-rimmed wheel, suitably connected to the Ackerman axle. Two condensers are supplied; the first of rectangular form, made of "Clarkson" tubes, fitted into aluminium side pockets, partitioned to cause the steam to traverse a long path. The second condenser is behind the first, and is shaped to fit round both sides of the pointed front of the car. This has a single row of "Clarkson" tubes fixed in curved copper headers. There is also a water pocket, or "hot well," to collect from both condensers, and any uncondensed vapour is permitted to escape into the flue. Steel roller driving chains, $1\frac{3}{8}$in. pitch, with a breaking load of four tons, serve to transmit the power to the road wheels. The latter are of the twin pattern, 34in. diameter, with steel hubs and rims and oak spokes, the tires being solid rubber. The frame of the lens is of mild rolled channel steel, bent at the corners and riveted with transverse members to carry the engine and other mechanism. The axles, of steel, have case-hardened bearings.

The following are the details of a test carried out with this bus recently:—Capacity of omnibus, sixteen persons; number carried on test, seventeen; length of run, 32 miles; involuntary stops, nil; test hill negotiated, gradient 1 in $6\frac{1}{2}$ steepest pitch; speed up test hill, over 6 miles per hour; average speed throughout journey, $13\frac{1}{2}$ miles per hour; grade of fuel, Russian petroleum "Rocklight" brand; consumption of fuel, 6·75 gallons; consumption of water, 16 gallons; capacity of oil tank, 28 gallons; capacity of water tank, 24 gallons; cost of fuel per mile, $1\frac{1}{10}$ of a penny; cost of fuel per passenger per mile, $\frac{1}{16}$ of a penny.

The operation of these omnibuses under everyday working conditions will be watched with much interest.

DOCKYARD NOTES.

A CORRESPONDENT is worrying himself about the Russian battleship "Pshabia," which figured in our last notes. Pshabia has a fine realistic Russian sound, but it is, of course, a misprint for the Osliabia.

THIS ship, so far as we can ascertain, is still at Spezia, and likely to remain there. It is, however, exceedingly difficult to obtain authentic news of Russian movements just now. Indeed, there is with most people considerable uncertainty as to whether the Rossia and Rurik are or are not in the Far East. For ourselves, we can find no record of their return, though ships have certainly gone out to relieve them. The Rurik, of course, would make little if any difference, but the Rossia, though no longer the "terrible vessel" she once was, should still be no mean opponent. Her battery is so extensive that, despite her defective ammunition supply, she might be a very serious factor if she came into action after the first heat of it was spent. And from the fact that the avowedly obsolete Vladimir Monomakh is on her way out, it would look as though the Russian Admiralty is by no means blind to the great use that a far-seeing admiral may make of ships usually regarded as of no value. Of course, much depends upon the steaming capacity of the vessel, and whether she can accompany a fleet without proving a lame duck. The Vladimir Monomakh is reported to have recently received water-tube boilers, but this report lacks confirmation. If she has been so treated, then it may be taken for granted that she would be able to keep up with the Russian battleships. The Rurik, on the other hand, though no more obsolete, has her old and original boilers, which were said to have shown signs of bad wear a couple of years ago. It is doubtful whether she could maintain even 12 knots, and the Russian battle fleet should be at least able to do 14. She would, therefore, be a serious hindrance. The exact speed of the Rossia is not known. On trial she exceeded 19 knots for a short spurt, but probably never had a sea speed of more than 18. This speed is still claimed for her by some Russian officers, but in view of the scanty docking that she can obtain the odds are that 16 knots may be nearer the figure, unless means have been found to scrape and re-coat her bottom. Her engines and boilers, when last heard of, were spoken of as "in good condition." The boilers are of the very earliest Belleville type, without economisers, and probably exhibit that heavy coal consumption which, previous to the introduction of economisers, was regarded as the chief drawback to this type. The Rossia's radius is, therefore, probably far inferior to that of the Gromoboi, which, so far as lines and horse-power go, is a sister ship. If Russia and Japan go to war, coal endurance is likely to be the factor of supreme importance. Coal economy is an art which Russian naval engineers, save in one or two of the most modern ships, have as yet not progressed so far as the engineers in some other navies.

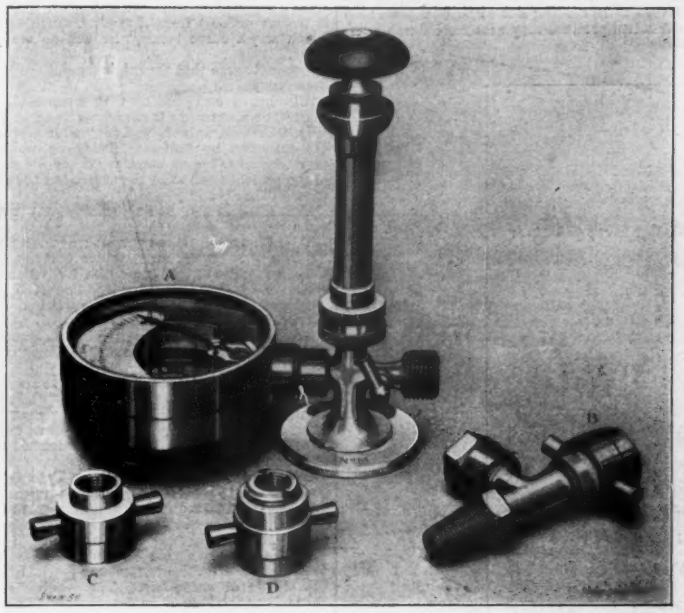
ON Tuesday afternoon submarine boat No. 3 came into collision with a Ryde steamer. It appears that the boat was passing Victoria Pier, Portsmouth, and the steamer coming out of harbour, made for this same pier. This brought her right across the submarine, which struck her just by the starboard paddle and "went a good way in." The "fragile" submarine was none the worse, but the steamer was sufficiently injured to make all speed for the beach, where she remained.

THE boat was running awash at the time, with her "lid" open. The impact forced her nose under water as far as the conning-tower. One of her officers promptly shut this down, so that had the boat gone completely under she would not have suffered thereby.

THE RAILWAY CLUB.—A special general meeting of the Railway Club was held on Tuesday, December 8th, at the Memorial Hall, Farringdon-street, to consider certain proposals affecting the future proceedings of the Society, and suggested alterations in the rules, &c. Mr. J. F. Gairns occupied the chair. The president, the Rev. W. J. Scott, made an effective speech, in which he dealt with the propositions of the Committee. At the conclusion of the business a paper, written by Mr. H. P. Blydt on the Talyllyn Railway, Merionethshire, North Wales, was read by the hon. secretary.

PORTABLE GAUGE TESTER.

THE new Factory Act requires that every boiler shall be fitted with a pressure gauge in proper working order, and the boiler inspector is required to sign a declaration (Prescribed Form, Factory and Workshop Act, 1901, Sec. 11) that, at the time of his examination, the steam gauge as well as the other mountings were in order. The condition of the safety valve and water gauge can be readily ascertained by examination; but nothing can be learned of the condition of the steam gauge, except by actually testing it against some standard known to be correct. If the gauge on the boiler is shut off from the latter, and put into communication with the atmosphere, the gauge may be tested as to its correctness at atmospheric pressure, when falling, but this, of course, is no proof that the gauge is in good working order. The gauge



VULCAN CAUGE TESTER

index may fall to zero when the pressure falls to atmosphere, and yet the gauge may be entirely untrustworthy.

Even if a boiler gauge is compared with a standard gauge at a number of points between atmospheric pressure and the maximum working pressure in the boiler—and this will be a difficult test to be accomplished without the use of the apparatus now being described—there will be no evidence that the gauge will register accurately above the usual pressure in the boiler. Now this is the very place where accuracy of reading is most necessary, and it is always the place where the gauge is most likely to err. For example, if the maximum working pressure in a boiler is 160 lb., the gauge will never under normal working conditions be subjected to a greater pressure, and the index will never move beyond the number 160. If, however, owing to the safety valve being stuck or being seriously overloaded, the pressure inside the boiler should rise above the allowable maximum, the gauge owing to want of use, may fail to register correctly, and, in fact the index may fail to register a single pound above the figure 160. This failure of the gauge may, of course, lead to disastrous results.

The next most important point for accuracy with a boiler gauge is the zero point. Should the gauge index point to zero when the pressure has not fallen to that of the atmosphere, a serious scalding accident may result.

To enable a boiler inspector to make a correct and precise statement as to the state of the boiler gauge, and to enable gauges to be conveniently tested and compared with a standard gauge at all desirable pressures, the "Vulcan" portable tester has been designed. The instrument is the invention of a member of the engineering staff of the Vulcan Boiler and General Insurance Company, Limited, King-street, Manchester, and it has been adopted for the general use of the inspectors. The apparatus is illustrated by the accompanying engraving. An essential part of the apparatus is the pump, by which any desirable pressure can be obtained. One end of this pump is securely attached to the base, on which the apparatus can stand when desired, as shown in the engraving. The other end of the pump barrel is provided with a little cup, into which water is poured when it is desired to employ water in the pump. The piston-rod, is provided with a small wooden discoidal handle, by which pressure for pumping can be easily exerted by one hand. Although air is usually employed in the pump barrel, water may be used when necessary. When air is used, several strokes will usually be required to get up the requisite pressure, whereas with water a fraction of a stroke will usually be quite sufficient. In the figure the standard gauge is a Bourdon, A, which is normally a fixture; opposite to it, at the other side of the pump, is screwed the gauge to be tested. This is put in connection with the delivery chamber of the pump by means of a nipple or union piece C D, of which three are usually provided. A T-piece B is also usually provided for convenience in attaching the apparatus in certain cases, and an adaptable nipple for a quarter gas thread completes the usual outfit. The stop cock controls communication between the pump and the gauge to be tested. A small screw at the opposite side is provided for allowing the water or air to leak from the pump delivery chamber, so that the pressure can gradually be reduced.

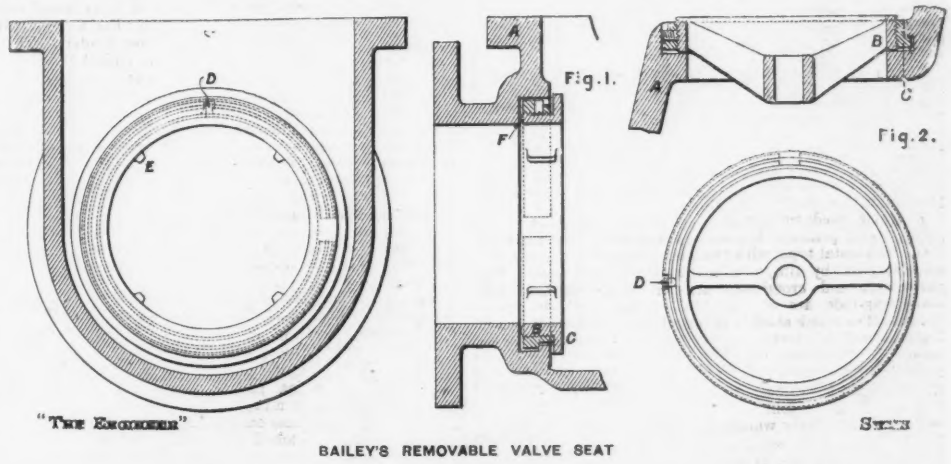
When it is desired to test a gauge in position on a boiler, the apparatus can be fixed up in one or other of several ways, as, for example, to a pillar syphon for testing the boiler gauge.

In making such a test the stop cock on the boiler is closed, and the tester fixed in position, use being made of the T-piece B, which is shown in the engraving. Pressure is then raised by the pump previously charged with water till the standard gauge reads the same as the gauge to be tested. The boiler cock is then opened, and after making sure that the readings of the two gauges are exactly the same, the pressure gauge stop cock is opened. Both gauges are now in communication and under the same pressure, and their readings can be compared. Pressure is first got up in the standard gauge to prevent any sudden jump or increase in pressure when the gauge cock is opened, which might act injuriously on this gauge. If the boiler cock is now closed the pressure to which the gauges are subjected can be gradually dropped and the readings of the two gauges compared. By means of the pump the two gauges can also be subjected to a greater pressure than the pressure in the boiler. Instead of applying the piston to a pillar syphon, it may be attached to the water gauge mounting, or, in fact, to any convenient fitting.

That the instrument is appreciated by the owners of boilers is shown by the large number of corporations and eminent engineering and manufacturing firms who have ordered instruments, although the apparatus has only just been put on the market.

REMOVABLE VALVE SEAT.

THERE can scarcely be a single mechanical engineer who has not at some time or another had to face trouble with the seats of screw-down or sluice steam valves. Sometimes it is due to simple wear, other times to scoring and cutting, not infrequently it is caused by distortion produced by expansion. Whatever the cause, the valve has to be ground or faced in place, or after removal with some difficulty. Now all that is to be changed. Sir William Bailey and Co., of Manchester, have brought out a new removable valve seat which really looks like being successful. It is illustrated in two forms by Figs. 1 and 2. The first shows it as applied to an ordinary gate or slide valve. A is the body of the valve;



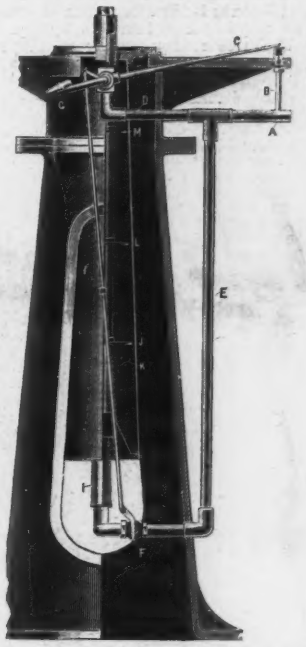
BAILEY'S REMOVABLE VALVE SEAT

C is a cast iron ring split at one side and screwed inside. It is sprung into a recess in the valve body as shown. A screw, D, in the ring prevents it from turning, whilst the valve seat B is, by means of the lugs E, screwed into it, and hard down on to the face F. It will be seen that the joint is made on this face, and that as the ring C is loose, no warping or twisting of the face from unequal expansion can occur. The valve shown in Fig. 2 is constructed on precisely the same plan, and the same lettering applies. Messrs. Sir William Bailey and Co. are putting these seats in all their steam fittings. A valve has been submitted to us for inspection. The seat may be screwed in or removed with great ease.

THE price of electric current for motive power in Rotherham has been reduced to 1½d. per unit for the first two hours per day and 1d. after.

A MINER'S SAFETY-LAMP TESTER.

YEAR by year improvements have been made in the miner's lamp to render it safer in presence of gas, but explosions due to faulty lamps are still numerous, and comparatively little has been done to secure an efficient test of each lamp before it is taken down the mine. A patented apparatus for quickly and effectively testing lamps in the lamp-house before they are given out was described by Mr. W. H. Johnson at the meeting of the Manchester Geological and Mining Society last week. This miner's safety-lamp tester, of which we give a sectional drawing, is designed for daily and rapid testing alone—not for testing the relative qualities of various lamps—and can be operated by an inexperienced workman. In order to save labour the table of the machine is fitted with various



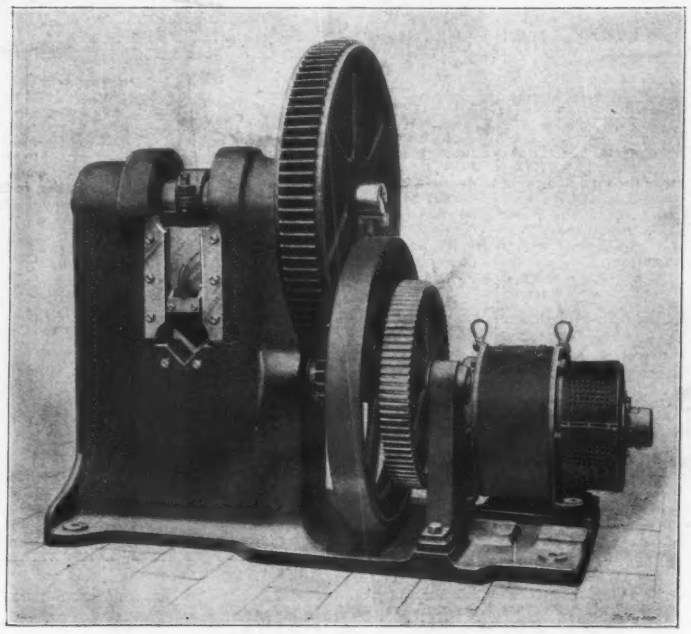
MINERS LAMP TESTER

trimming attachments, such as for screwing, or unscrewing the lamp bottom and glass ring, for cutting off the rivets, and again for sealing the rivets. The actual testing part of the machine is very simple in construction, and is entirely confined within a cone in the centre of the stand. From the section we give of the tester the arrangement and method of operation will be understood. The tube A can be connected to an ordinary gas supply or coupled direct to compressed coal gas or hydrogen. The branch B, supplying the igniting jet, is always kept burning when the tester is in operation, and is used for re-lighting the igniter C, the latter being sometimes blown out by the explosion of imperfect lamps. The gas-pipe separates at the tee D, running horizontally and supplying the gas to the igniter C; and E, seen in a vertical position, leading to the tap F at the base of the cone. The tap F, being turned on by the handle G by connector rod H, the gas flows into a Bunsen burner I, receiving a mixture of air as it enters. It returns out of the inner cone, and receives another admixture of air. It then flows to the baffle plate J, which assists in making a proper explosive mixture, and receives a further supply of air from the rents K in the outer cone. The same process is duplicated at baffle plate L, and again at M. At this point an almost perfect explosive mixture is continually flowing up the cone and escaping at the top. With the explosive mixture continually rising in the cone and escaping through the holes at the top, a lamp, on being placed over the top of the holes, is at once filled, and the mixture is prevented from escaping, except through the meshes of the gauze or joints of the lamp. On the application of a light to the outside of the lamp, filled as already stated, it follows that the gas escaping through the meshes of the gauze will ignite, and burn slowly, provided there are no spaces in the gauze or joints large enough to allow a flame to pass through it into the inner part of the lamp; on the other hand, should there be any aperture large enough to allow a flame to pass through, it would immediately light back into the inner chamber of the lamp, causing an explosion. The novel feature of this system of testing is that

the lamp is filled with an explosive mixture, and a light is burning outside the lamp, exactly the reverse of what occurs in the safety lamp when in the mine. The advantages claimed for this method are that the current of gas, rapidly rising inside the lamp, exposes the lamp to as severe and certain a test as it would experience in a mine if standing in a rapid current of gas, and a series of tests to which perfect and imperfect lamps were subjected by Mr. Johnson amply demonstrated its efficiency for detecting an imperfection which would render a lamp unsafe in the mine.

ANGLE CROPPER.

Below we illustrate a machine made by Messrs. Rushworth and Co., of Sowerby Bridge, for a firm of bridge builders in Canada for cropping angle iron 3½in. by 3½in. by ⅜in. of any length. The machine is quite self-contained, requiring little or no foundation, and is driven by a motor with raw hide pinion and machine-cut spur wheel. It is provided with a heavy fly-wheel, turned true, and a second-motion gearing, shrouded to the pitch line. The excentric shaft is of steel, and a stop motion is fitted to the slide. The main feature to be noted in this machine is the little space occupied and the arrangement for driving by motor.



ANGLE IRON CROPPER

CATALOGUES.

Boulton and Paul's, Limited, Norwich.—Abridged catalogue of outdoor requisites.

Beanland, Perkin and Co., School Close Works, Leeds.—A pamphlet issued by this firm entitled "Labour Savers and Time Savers," gives illustrations and particulars of hack saws, rail saws, and grinding and screwing machines.

C. and A. Musker, Limited, Liverpool.—We have received a set of large size collotype prints from Messrs. Musker showing views of a hydraulic power installation for suspended passenger lifts. The illustrations are produced in an excellent manner.

Power Plant Company, Limited, 20, New Bridge-street, London.—Illustrated leaflets illustrating portable two-stage one-cylinder compressors; percussive pneumatic coal-cutting machine; the "Globa" worm gear with roller wheel; and an electrical hand-drilling machine.

J. Sagar and Co., Limited, Canal Works, Halifax.—A special circular on moulding and planing machines has been issued by this firm. The contents include wood engravings and particulars of a machine for planing floor, ceiling, and partition boards, a four-cutter machine for hard colonial wood, and a similar pattern of machine for soft wood.

Tangyes Limited, Birmingham.—Steam engine catalogue, No. 60, containing particulars of single-cylinder and compound horizontal and vertical engines. The makers point out that all horizontal and vertical engines, in which the steam distribution is effected by flat unbalanced slide valves, may employ superheated steam of not more than 400 deg. Fah. total heat.

Watson, Laidlaw and Co., 98, Dundas street, Glasgow. 1904 catalogue of "Weston" centrifugals and accessories.—Everybody interested in the sugar manufacturing process will appreciate the care and taste which has been used in the production of this book. Sectional drawings showing the essential details of the machines very clearly demonstrate the perfection to which this class of apparatus has been brought in a comparatively short period.

Thos. Broadbent and Sons, Limited, Central Ironworks, Huddersfield.—Crane catalogue. This is a handsome volume, dealing with electric cranes up to 100 tons capacity. The firm has standardised two types of electrically driven overhead cranes, namely, the multi-motor type, with three, four, and more motors, and the mono-motor type. The admirable illustrations are reproduced from photographs of cranes constructed and erected by this firm.

It has been said that the marriage rate of a country is a safe criterion of its material welfare. If this contention holds good, Germany is on the down grade. In 1899 the number of marriages was 471,719; in 1902 it was 457,208. Again, in 1902 the number of marriages per 1000 inhabitants was 7·9, in 1901 it was 8·2, in 1900 8·5, in 1897 and 1898 8·4.

STEAM TRAPS.

At a meeting of the Manchester Association of Engineers held on Saturday there was an interesting discussion on steam traps. Mr. Joseph Butterworth, who introduced the question, said not many months ago one of their members made the sweeping statement that there was not a good trap on the market. The fact was the average engineer would not take the trouble to understand the conditions under which a steam trap had to work. What was required was a trap that would perform miracles. It must go into the pipes and cylinders and extract the water from the steam previous to draining it off; it must be able to pass any sort of solid material from a ½in. nut downwards, and it must be able to upset the laws of nature by passing water at 3 deg. to 400 deg. Fah. into the air without emitting steam. Dealing with the various kinds of steam traps in use, Mr. Butterworth said most of the recent types of float traps had the valve controlling the discharge of water placed at the inlet to the trap, so that by having the outlet to the trap large enough little or no pressure was exerted in the trap itself. This type of trap had many advantages, such as lightness, simplicity, and cheapness, compared with the old float traps; also owing to the working parts not being under steam pressure they were more durable and certain in their action. In numerous similar traps since invented the action was similar to that of an automatic weighing machine, as the water, after leaving the valve, passed through a tubular lever into and through the float into the trap. By this arrangement the normal position of the trap when steam was off was full open, also any derangement of the working parts would leave it in the same position; whereas in most other float traps the reverse was the case, which, in his opinion, was an element of danger, as the mechanism was always liable to get stuck while standing, especially if dirty water were passed by the trap, and certainly it was better that the trap shou'd stick open than shut, so that attention was at once called to the fact by an escape of steam instead of by an expensive smash of mechanism. There was also the further advantage that these traps would work equally well with the cover removed, so that they could always be examined. Referring to the expansion types of traps, he said there was no doubt they had latterly been more in use than when first introduced. There was no difference in the principle upon which they worked compared with old traps, but better workmanship, and a more intelligent distribution in the metal to withstand the immense strains they had to meet, had rendered them more successful than formerly. Their chief advantages were the small space occupied, and the ease with which the outlet, being small, could be connected to a drain. Their disadvantages were the infinitesimal movement of the valve at the range of temperature which took place when the plant was under steam and the great strain thrown on the material of the trap by the lever introduced to increase the lift of the valve.

TRADE AND BUSINESS ANNOUNCEMENTS.

The Foxgrove Machinery Company, Limited, of Creek-street-chambers, Leeds, has moved into larger premises, Admiral-street, Dewsbury-road, Leeds.

We understand that the first Garden City is commencing operations by boring an artesian well in search of an ample supply of pure water. The founders have placed this work into the hands of Messrs. Le Grand and Sutcliff, of London, who started boring last week, commencing with 16in. tubes, at a high elevation on the estate, on the road between Baldock and Hitchin. A depth of over 100ft. has already been penetrated into the lower chalk formation, from which an ample supply is expected.

Society of Engineers.—The Society of Engineers has a reputation to maintain for giving enjoyable dinners, and that reputation was more than upheld by the annual banquet held last night. Between eighty and ninety members and guests sat down. The president, Mr. Patten Barber, was in the chair, supported by the presidents of kindred institutions and Mr. Christie, the Astronomer-Royal. The speeches were short but to the point, and the programme of music was capital. We are glad to learn that the Society continues to make headway, its membership roll at the present time showing a steady increase. It may be recalled that next year the Society will celebrate its jubilee.

The South Indian Railway Company.—The report for the half-year ended on June 30th states that the total revenue earnings were Rs. 61,12,964 and the working expenses Rs. 22,91,410, or 37·48 per cent. of the earnings, as against 46·84 per cent. in the corresponding period. The net earnings were Rs. 38,21,554, and after making adjustments for outstandings appertaining to previous half-years, the amount at the credit of this account for the half-year is Rs. 38,26,298, showing an increase of Rs. 10,27,582. The increase of Rs. 4,52,588 in the coaching receipts brings the total to the highest sum received in any half-year. The locomotive expenses continued to be lower than normal owing to the deferred charges for new engines which will come into succeeding accounts.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

STEAM TURBO GENERATING PLANT.

Sir,—In this correspondence the original question, in which results of my tests on the Cambridge plant were compared with those of Professor Ewing in a manner unfavourable to the latter, is gradually being passed over by the champions of reciprocating engines. I think, before further items are raised, it might be well to settle this.

On the 20th ult. your correspondent said I was wrong in my figures respecting the value of vacuum; on the 8th inst. he says "possibly I am wrong," and when I tell you I have authority for saying that "the results of more recent tests on turbines"—than the one on which the table published in the "Minutes of Proceedings," Inst. M.E., Glasgow Congress, was based—"show that the curve really bends down, and that the earlier test was based on so small a range of vacuum as not to give the curve accurately. It is always difficult from a small "range of tests to determine which way a curve bends," he will do me justice to say I am right.

I cannot agree that the original point is a fine one; 13 per cent. deterioration in one year's wear, as alleged, needed correction; but I quite agree 1½ per cent. to 2 per cent. increased consumption, when a separator is not in use, is an extremely fine point. I may, therefore, I think, without undue presumption, assume that the statement by Professor Ewing on which my share in this correspondence began, namely, "I am of opinion that the results of the present trials show that there has been no deterioration due to wear," has been sustained.

In a letter, dated November 20th, my attention is drawn to some tests of Belliss engines referred to in the "Min. Proc." Inst. C.E., and on these figures I made some comments in mine of the 30th ult. It appeared to me that not only were the trials incomparable without correction for vacuum in favour of the original trials, but that a deterioration of 5 per cent. had taken place due to wear. I am anxiously waiting a reply to this. The value of this correspondence is very small to your readers if statements when started are not fully substantiated or withdrawn. May I appeal to Mr. Morcom to continue this portion of the discussion?

Again, Mr. Swinton and I are accused of attacking Mr. Morcom's examples of station results. I fear he forgets he is the attacking party; he began by alleging that turbines are greatly inferior to reciprocating engines, whilst we are defending only. I have as yet only tried to prove in defence that turbines are on at least an equal footing.

Now, to come to the Newcastle-on-Tyne figures, I have not the good fortune to possess a copy of the returns for this station; my figures were obtained from a printed report of the chairman of the company's speech issued by the company, and the figures quoted are for nine months later than two of Mr. Morcom's reciprocating examples, the same year as one and three months earlier than four. Leeds is included in the last four. I think that disposes of the charge of unfairness. The Newcastle-on-Tyne figures are certainly not published in the technical Press, but surely this is not the fault of turbines or a prohibition on their use.

Now, before we go any further, may I be allowed to clear a little ground. I have had some experience in buying and selling engines, and I never remember a case where the guarantees were other than the amount of steam consumed per kilowatt or per horse-power, omitting maintenance for six or twelve months. May we not therefore confine ourselves to coal and load factor, at any rate for the present. I have already pointed out that "stores and oil" and "repairs" include dynamos, mains, batteries, buildings, &c. Even if you placed your valuable space at our disposal, these other figures would require much more time than I have at my disposal to reduce them to the common denominator of turbines and reciprocating engines.

Newcastle-on-Tyne figures are for units sold, not generated, if the chairman is to be believed. Page 1 of his speech says, "The number of units sold during the year was 5,537,500," which includes wholesale to Wallsend and retail to Newcastle city. Further, on page 2, the number sold retail in Wallsend is given, and the whole of the sales retail are 5,011,300. Before I accept these figures for the reduction to price per unit in coal, may I ask how many units are sold wholesale in Leeds?—for I believe all the public lighting is so metered. Even if we take this lower figure of total units sold, the coal still is ·24. per unit against Leeds ·28, a superiority of 27½ per cent. Mr. Morcom may have later knowledge of Wallsend power house than I, but during 1902 I was in the station almost every week, and the turbine did by far the larger portion of the work. I note the parentheses re the load factor, which reads as though I had wilfully suppressed essential figures. I stated in my last letter, against the table, that the figure was not available, and even now I do not know what it is.

However, I am prepared to go further in meeting Mr. Morcom, as he objects to Newcastle in my list, and take it out. I must also remove Leeds, and we now have:—

			Coal.	Load factor.
1901.	Newcastle and district	1,619,671	·69	13·67
1902.	Cambridge	419 005	·66	9·13
1902.	Scarborough	431,777	·85	9·34
1902-3.	West Bromwich	285,848	·55	9·27
		Average	·687	10·35
1902-3.	Bootle	1,619 129	·41	28·44
1902-3.	Taunton	646,373	·70	12·77
1901-2.	Yarmouth	418,021	1·38	9·74
1901-2.	King's Lynn	286,679	·59	15·58
		Average	·77	16·63

The result is:—

	Coal.	Load factor.
Turbines average	·637	10·35
Engines ,,	·77	16·63

Now, as to Yarmouth. Why may I not "drag" it in? An appeal has been made to the list in the *Electrical Times*, and when I select a town from the same list as nearly comparable to Scarborough as is possible, but to its own disadvantage in load factor, an objection is raised. How, then, can your readers prepare a list for themselves for a few pence if they may not take the figures from the list?

However, to pursue this new argument, which I shall presently show is two-edged, surely the engineer at Yarmouth is the best judge which coal gives him the cheapest result, and I presume he is of opinion that Welsh will produce more pounds of steam per pennyworth of coal than any other.

On this coal basis, let us take Leeds and Cambridge. Both are using smudge; the railway and cartage rates to the latter town are from a minimum of 8s. 6d. per ton from Nottinghamshire, to 9s. 6d. per ton from South Yorkshire. The price paid for coal is, I believe, from 10s. to 11s.—in my time as low as 9s. 9d.—let us say 10s. 6d. Value of coal is, therefore, 2s.; shall we say 2s. 6d? Leeds presumably has a siding, and their carriage rate should not be more than 2s., making smudge 4s. 6d. per ton, and on this basis we have Cambridge coal ·283 pence per unit. May I ask now where is the superiority of Leeds?

Mr. Morcom says he can show thirty-eight stations giving an average of ·41 for fuel, but this is less than a quarter of the reciprocating stations in the list. What about the remainder?

Does Mr. Morcom seriously maintain he took trouble to make a comparable list when all of the reciprocating stations he selected are condensing, and two of the turbine stations non-condensing, or only partly so, when the turbine load factor is 10·56 per cent., engine 15·67, when one of his stations was partly water-driven?

I drew his attention to the load factor in my last letter, but I am afraid I cannot follow his reasoning. The total amount of plant in a station has no relation to load factor whatever, and as far as I know, the maximum reading in all stations is based on the maximum demand made on a station during the year, whether turbine or reciprocating. If the load factor has no close bearing on economy, why should Mr. Morcom accuse me of suppressing Newcastle-on-Tyne? However, I am sure of the support of all station engineers in my view of the value of this figure.

Lastly, Mr. Morcom makes a series of *ex parte* statements regarding turbines, to which consideration for your space prevents my replying. No doubt he will refer me to the mishap at West Bromwich; in the absence of a reply to this by the builders themselves, I shall be happy to give what I consider a perfectly satisfactory account, as I am conversant with the particulars of this case.

In one paper Mr. Thomas, of Huddersfield, draws my attention to the record and excellent results obtained in his station. I sincerely congratulate him on it. I would, however, point out that all his units are sold on the switchboard, and at least 25 per cent. must be added to the cost to bring them to units sold, so that for my purpose his costs are ·45 per unit.

I should also like to learn how a station of 2300 horse-power can be run for twelve months for the sum of £20 (twenty pounds) in oil, waste, water, and stores. Perhaps Mr. Thomas will give us the benefit of a complete list of his purchases on this head, debiting his stock of stores at the beginning of the year, and crediting those at the end.

JOHN H. BARKER.

Falcon Works, Loughborough, Leicestershire,
December 14th.

SIR,—I have read with interest the correspondence following on Mr. Wilkinson's paper. As I hope to have shortly an opportunity of dealing with this question at greater length than is possible in a letter, I will not discuss in detail the accuracy of the figures quoted by your correspondents; but as more than one reference has been made to the Wallsend plant of our clients, the Newcastle-upon-Tyne Electric Supply Company, I think it well to point out that the results quoted depend upon such a variety of factors, that in the absence of fuller information any deductions therefrom are liable to be quite misleading.

As Mr. Lea points out, an attempt is being made, based upon entirely inadequate information, to compare plant working under conditions which differ almost as widely as the machines themselves.

The first of the two 2000 k.w. turbines now working at Wallsend was ordered more than three years ago, and it is sufficient indication of our opinion to say that as a result of our experience we have recently placed orders for six Parsons' turbines with an aggregate output of over 11,000 k.w. for our clients, the Newcastle-upon-Tyne Electric Supply Company and the Priestman Power Company.

We have also on order for another client a 500 k.w. Curtis turbine, which will, we believe, be the first turbine of this type to operate in a central supply station in this country.

CHARLES H. MERZ.

28, Victoria-street, Westminster,
December 15th.

SIR,—Mr. Morcom, in his latest letter on the above subject, quotes the fact that for the year 1902 the cost of coal at Scarborough was ·85d. per unit, while at Cambridge, with a less output and a lower load factor, it was only ·66d., as a proof that load factor and, presumably, output also, have "no very close bearing on the relative economies." He adduces this in support of the utility of his comparative tables, in which, as I have shown, his selected reciprocating engine stations have, on the average, a 50 per cent. better load factor and 100 per cent. greater output than the turbine stations. Now, for the year 1902 the Scarborough load factor was only about 2½ per cent., and the output only about 5 per cent., better than the corresponding Cambridge figures, and while 2½ per cent. and 5 per cent. differences may very well be masked by other conditions, this is not so likely to be the case where it is a matter of differences amounting to 50 per cent. and 100 per cent.

Mr. Morcom's whole argument on this point is illustrative of the extreme danger that attends his method of making comparisons between stations as to the precise circumstances of which he is necessarily ignorant. He could not very well be aware of it, but the reason for the superior fuel economy attained at Cambridge over Scarborough in 1902 is perfectly well known to me. It was simply due to the fact that during a considerable portion of the year in question Cambridge was working with much larger, and therefore more economical units of plant than were in use at Scarborough.

The effect of this was to more than counterbalance the slightly superior load factor and output of Scarborough, which, by themselves, would, of course, have a contrary tendency.

Further, in objecting to my criticism of his comparisons on the score of load factor, Mr. Morcom is not consistent. When it suits his own purpose, as in the case of the comparison he makes between Leeds and Newcastle, he himself calls in the matter of load factor to support his argument.

What is, however, altogether amazing is that Mr. Morcom appears to be ignorant as to what is really meant by the term "load factor" in connection with ordinary electric supply stations. He surmises that the inequality in the load factors that I have pointed out "might be due to anxiety on the part of the turbine stations to hold a big margin of spare plant." What in the world has spare plant to do with load factors? As everyone knows, it is a matter not of plant capacity nor of special load, but of ordinary maximum load actually ascertained in practice. The poor load factors at Cambridge and at Scarborough are easily understood when one remembers that at Cambridge a large part of the output goes to colleges which are practically shut up for about half the year, while Scarborough is a watering-place with a very short season in the summer months, where the maximum load in kilowatts actually occurs in the beginning of September, instead of in December, with its much shorter days, as is the case in most places.

No doubt, both at Cambridge and at Scarborough at the end of the year 1902, the amount of plant installed was considerably in excess of actual requirements. The reason for this was twofold, viz., a considerable provision in each case for extension, and also the fact that in both stations some new and much larger, and consequently more economical, units of plant had just been installed to replace the original smaller units which sufficed when the load was less, which smaller units had not then been removed, as has since been done to a considerable extent.

Here, again, we have an illustration of the way in which Mr. Morcom is arguing about places with the special local conditions of which he is evidently unacquainted. This is further evidenced by the fact that among his selected reciprocating engine stations he included Salisbury, where, as I have already mentioned, a large proportion of the generation—to the extent, I am authoritatively told, of one-third of the total units—is carried on by water power. I do not find any allusion to this matter of Salisbury in Mr. Morcom's reply to my criticisms.

With regard to the Leeds and the Newcastle-on-Tyne stations, Mr. Morcom's comparison, as I understand, refers to the figures for the year 1902, when, as I am informed, the Newcastle station was still running largely with reciprocating engines. Consequently, the results are but of small moment in relation to the present controversy.

For the year 1903, whether the figure is Mr. Barker's ·38, or the still lower figure which, as I understand, is now being attained, even if we accept as necessary Mr. Morcom's allowance of 20 per cent. for the difference between units generated and units sold, we shall still have a result which I am sure it will take Leeds all its time to equal, and this with almost the whole Newcastle output generated by turbines. As to this, however, no doubt it will be best to await in patience the publication of the exact figures which ought now to be available in a few weeks.

In conclusion, I would point out that cost of fuel, labour and upkeep do not comprise the whole matter. There is also the question of first cost, both of the engines and dynamos themselves, and also of the foundations and buildings. Interest on capital expenditure being a very large item in the final result, these latter matters must not be overlooked, and there can be little doubt that, in respect to these, the turbine has the advantage.

Finally, I would say that, after a very considerable and somewhat exceptional experience of several thousands of horse-power of steam turbines, both for electrical and also for other purposes, covering in all a continuous period of some eighteen years, I am satisfied that, though in the earlier days there were admittedly not a few cases of blade-stripping—just as there were many broken crank shafts in the earlier development of high-speed reciprocating engines—this is not now a contingency that need be taken seriously into account, given only proper workmanship in the first instance, and reasonable care in running. In fact, under similar conditions in these respects, I have no hesitation in expressing my opinion that the steam turbine is now quite as trustworthy as any other form of steam engine.

A. A. CAMPBELL SWINTON.

66, Victoria-street, Westminster, December 14th.

SIR,—Mr. Wilkinson states in his letter published in your last issue that "it is an undoubted fact that turbines give no trouble when working with superheated steam," and further on he mentions West Bromwich as a station where the turbine plant has the distinction of being not obsolete. Now, I have information that at a station not very far from West Bromwich, about a fortnight since, about one-fourth of the total number of blades were stripped off one of the turbines, that the trouble was attributed to superheated steam, and that the blades are to be replaced by others of a metal specially adapted to withstand the effects of superheat. I also know of the same thing having happened not long since at another station, the failure again being attributed to the use of superheated steam. At this station reciprocating engines were in use as well as steam turbines, and when subsequently extension sets were required reciprocating engines were installed. I have also heard of the blades being stripped off a large turbine in the States where superheated steam was in use.

These sort of experiences are not, as a rule, published in the papers; indeed, it almost seems indecent to drag them into light, but if without any special sources of information I have heard of three different instances of trouble with superheat, no doubt others have occurred which have not come to my knowledge.

Perhaps Mr. Wilkinson might say as to experiences he has had with blades being stripped off the turbines at his station.

RECIPROCATING ENGINE.

STEAM TURBINES.

SIR,—In answer to the inquiry of your correspondent "F. I. D." regarding Professor Stodola's book, he is correct in understanding that the changes of pressure measured in the nozzle are from point to point along its axis and are maintained steadily, there being no change from second to second at each point. This was clearly explained in the review of the book. As to what is called the sucking action of a component of the jet pressure upon the buckets the components of any total force are here, as usually, the results of mathematical analysis; they seldom have separate physical existence. The components perpendicular to the axis of the wheel have no effect in pushing the wheel either way along the axis. The component along the axis tended, under the special conditions referred to, to push the wheel along the axis from the discharge side towards the inlet side or entrance-guide side.

YOUR REVIEWER.

December 13th.

THE LATHE OF THE FUTURE.

SIR,—Your suggestive article on "The Lathe of the Future" shows us that, notwithstanding the many modifications introduced of late, there has been no very marked improvement in the construction of the sliding, surfacing, screw-cutting lathe. But, as you say, "There are many persons who deprecate the use of the general service lathe," and the tendency during the past dozen years has been to endeavour to find substitutes for it. Inventors have been at work on the "roundabout," the vertical and horizontal boring mill, the turret lathe, &c., even the milling machine now doing work that was formerly done on the lathe. But they have not superseded it; indeed, the versatility of the general screw lathe is becoming more clearly recognised.

It is, however, as you point out, capable of improvement. Your article clearly points out one or two defects that will doubtless be seen to in the near future. The capital defect appears to be the absence of provision for automatically varying the speed of the lathe when cutting transversely. But there are other points, not perhaps of such capital importance, in which there seems no decided consensus of opinion as to what is the best practice; and as evolutionists tell us that evolution does not always mean increased efficiency, it might be desirable to show these differences of opinion, in order to see, if possible, what is the best practice.

About five years ago I was employed as a turner by a very old-established firm where tools of fifty or sixty years of age were working side by side with others of the latest construction. The lathe I was working, a 24in. centre Whitworth screw-cutting lathe with a sliding bed 20ft. in length, did a great variety of work. The gap when the bed was slid back allowed a job 7ft. in diameter and 6ft. in length to swing in the chuck, and it was used for cylinder, piston and ring, and air pump work, as well as for crank shafts, piston-rods, &c., between the centres. The reversing gear of the usual Whitworth bevel wheel type could be actuated by a touch even when running at the highest speed. The fast headstock consisted of a solid block fitted accurately into the bed of the lathe. Two compound slide rests on the saddle, separately movable in any direction, with traversing arrangement by overhead gear, completed the equipment. This lathe was made by Whitworth in 1853, and I was told it had been almost continuously at work at least forty years when I started to work it. The split nut for the leading screw had been twice renewed, and the bearings of the triple gear shafting of the fast headstock had been twice bushed, but with this exception it was as it came from the maker. I worked the lathe about three years, and found that it worked with a power, a speed, an ease, an accuracy, a freedom from vibration, that I have not seen surpassed in my twenty-five years' experience.

During the past six months I have been working a 10in. centre screw-cutting gap lathe, with a bed 10ft. long. This is a new tool, made by a celebrated maker, and of the latest design. It has a back shaft for sliding the saddle and working the traversing screw, and the leading screw is placed in front of the lathe, instead of being inside the bed, as in the Whitworth lathe. There is the arrangement of the cone of wheels for changing the feed, and of the triple spur-wheel reversing gear at the end of the fast headstock.

I do not find this lathe any improvement on the Whitworth lathe, excepting, it may be, in the feed-changing arrangement. Owing to the lightness of the hollow fast headstock, there is a decided tendency to vibration, especially in swinging a job in the chuck. It does not fit accurately into the bed, as in the Whitworth lathe, but has the usual arrangement of adjustable screws, and I find it does not bore a parallel hole for any length of time, as the adjustable screws in this—and, I may say, in all I have worked—cannot be relied on to remain in the exact position in which they are placed. To work the reversing gear requires the stoppage of the lathe—quite unnecessarily, it seems to me, because I worked a lathe fifteen years ago which had a triple spur-wheel reversing gear that was capable of working while the latter was in motion.

Of course, reduction of first cost may have played the principal part in these alterations, and I am aware there is room for difference of opinion as to whether it is better to fit the fast headstock accurately in the bed or not. I can readily suppose the Whitworth lathe, made in 1853, was a very costly affair originally, but it has not by any means become obsolete. The newest lathe has no very decided advantage over it in design, and it certainly is inferior in comparative power, accuracy, and ease in working.

During the past twelve months I have been using the high-speed steel. You tell us of the owner of large works who finds the economy he effects by its use is no more than 5 per cent., and you suggest that the reason for this is to be found in the fact that in a well-organised factory "there is not much work from which any great weight of material should be removed," and that a surface cannot be finished with the new steel.

Though the economy effected by the high-speed steel may not be so great as enthusiasts anticipate, I find it is certainly more than 5 per cent. in cutting mild steel. In turning crank shafts or piston-rods, for example, I find I can run at more than double the speed I have been accustomed to with the ordinary steel, or even the Mushet tool. The finishing, it is true, cannot be done at a high speed, any more than it can be done by the ordinary tool if attempted in the usual manner. The usual plan has been to run the finishing tool at a slow speed and a feed varying from a quarter of an inch to half an inch, and even by this method the danger of "tearing" the job is difficult to avoid. I find I can finish mild steel with the high-speed steel at comparatively high speeds if the flat cutting edge is not more than one-sixteenth of an inch in width, with, of course, a corresponding reduction in the feed. But it is a question whether any material economy is effected by this, especially, as you point out, as the quality of the material varies so much.

And I find in cast iron work, cylinders, piston-rings, &c., for example, that the high-speed steel is very little better than the ordinary or Mushet steel until it gets well under the skin. The sand, I suppose, grinds it away at the high speeds. Its superiority, however, is manifest in finishing the inside of a cylinder or turning a piston or rings. I find I can finish with it a cylinder or piston at double the speed of the ordinary tool.

December 14th. A. TURNER.

BREAKDOWNS IN THE NAVY.

SIR,—The letter of "Superintendent Engineer" on this question is interesting, but suffers, I fear, from a defective appreciation of the situation.

Ever since the Boiler Committee of merchant service experts was appointed to decide on a purely naval question, the naval engineer has been the target for any amount of advice as to how he should do his job, coupled usually with a recommendation to study the mercantile marine. As by the Articles of War the naval engineer is prevented from replying, this particular sport—which is about as "sporting" as pigeon shooting—has had a considerable vogue. I would not wish to imply that "Superintendent Engineer's" letter comes exactly under that head, but I am tolerably sure that the absence of "replies," instead of being put down to the true cause, has been attributed to a general inability to answer, and "Superintendent Engineer," like many others, has been led to form false conclusions accordingly.

For instance, had he ever stood on the bridge of a man-of-war for a few minutes at sea and used his ears he would never, I think, have suggested sending naval engineers to learn their business in mercantile steamers. I have nothing to say against the mercantile engineers, the point is that the duties are so entirely different that he might just as well have suggested locomotives or motor cars.

The ship, as one of a fleet is, let us suppose, steaming, not at tactics and evolutions, but just ordinary steaming at, say, 90 revolutions. She has, even so, to keep station. This means that in the space of a very few minutes orders to the engine-room will go as follows:—90 revolutions, 92, 90, 60, 110, 98, 90, 80, 100, 20, 100, and so on. In the mercantile marine it would be 90 revolutions, and there the speed would remain. The instance that I have given is a fair sample of an "easy time" below in a warship. If tactics or a "battle" are on—and one or the other usually is on in naval manœuvres—then steaming at 90 revolutions means anything, from full speed astern one moment to "Go ahead as hard as you can" the next. What possible training for this kind of thing can practice in Atlantic liners or big tramps afford? The naval engineer has not only got to play about with his engines like this: he has also often to anticipate what the next order will be. I really do not think that the mercantile engineer is likely to be able to teach him how to suck this particular egg.

Then, again, does "Superintendent Engineer" realise the difference between engines cramped down below a protective deck, every possible ounce of weight cut down, and the engines of a liner subject to no such restrictions? Bless his soul! British naval engineers could tell him more about the idiosyncrasies of their engines than he has any idea of. That is the pet subject when three or more of them get together. Every warship has a certain permanent staff which loses no time in mastering little elementary troubles like that. I would wager naval engineers or artificers to run a liner a thousand miles before any mercantile engineers would run their warship fifty.

They know all about the mercantile engineer expert in the Royal Navy. They do not forget there how the mercantile experts said that the Belleville boiler was no good; how the pick of these folk who were to teach the Navy its job said that the Europa could not get out to China, much less return. Yet Engineer-Lieutenant Carnt took her out and back without a single defect. What, too, about the Andromeda, that after three years' hard work beat her contract speed by 1·8 knots? Or the Drake, with her 24·5 knots in place of the designed 23 knots? Or the Spartiate, the Goliath, and dozens, literally dozens, of other ships?

I do not want to seem rude, but I would assure "Superintendent Engineer" that the engineers of the Royal Navy have had just about enough of the superior virtues of the mercantile marine engineers. Time was when they had heard so much of it that they had almost come to believe it. But those days passed some time ago, and the Navy has had as much as it will stand of it. It submitted quietly to the appointment of mercantile engineers to judge whether its selection of boilers was correct, even though it knew then that the Boiler Committee was instituted to please members of Parliament who had to get journalists to explain to them the difference between the household kettle and the Belleville. But it has since quietly vindicated its own selection; and, having shown the civilian mercantile experts wrong on the question of naval boilers, it is certainly in no mood to be taught engine-"driving" by the merchant service.

In conclusion, I would again say that I would be the last to attack the mercantile engineers in their own sphere. In it they do excellently, but their work at sea is only a degree more onerous than the work of the naval engineer with his ship lying in harbour.

Machinery breakdowns in the Royal Navy are caused by the constructor's craze for cutting down weights in all modern engines, coupled with the inevitable crowding of everything into the smallest possible compass necessitated by battle requirements. I do not think that a single naval mishap can be attributed to the ignorance or inefficiency of our engine-room complements. In the

early water-tube days it was, I know, the fashion to attribute breakdowns which had no counterpart in foreign navies to that cause, but it has long since been proved that half these reported breakdowns never happened at all, and that the remainder were entirely due to faulty construction during the engineers' strike, amateur "improvements," and the substitution of a cheap Admiralty packing for the orthodox Belleville packing. Now that this fatuous policy has been abandoned, the only boiler troubles in the Navy have been with types selected for the Navy by the mercantile engineer experts. There would be none had matters been left to the naval engineers. Similarly, were there an engineer officer on the Board of the Admiralty no machinery troubles would occur, for the "too light" engines would cease to be fitted. I do not think that a harder working, more efficient and more practical body of men than our naval engineers are to be found, and anyone who knows anything of the Royal Navy will bear me out. Let us hope, therefore, that we shall hear no more implications of this sort against them. FRED. T. JANE.

Portsmouth, December 12th.

SUBURBAN RAILWAY TRAFFIC.

SIR,—We regret to trouble you with one more letter upon this subject, and though we fear that little is now being added of any value, one or two of "U. R. B.'s" statements do seem to ask for a reply.

We have not disputed that gentleman's figures, for the reason that he has given us little opportunity, not having given any figures to dispute, and the operation of tilting at a windmill is not one productive of much in the way of useful result. In our article we endeavoured to show—first, what acceleration is required for the fulfilment of suburban traffic conditions; secondly, how such acceleration bears upon economical working; and then, by a comparative statement, we have, we think, proved that though the required acceleration may be attained by means of a steam locomotive of extraordinary weight, the economical working of a railway cannot be effected by such a steam locomotive. All questions of retardation being equal in both cases, were not dealt with by us. "U. R. B." will be good enough to show in a somewhat similar manner, *i.e.*, by giving positive figures and exact diagrams, that the whole problem can be solved by some other means; we shall be glad to study with care his methods and conclusions, but they ought to be shown, we suggest, by means of speed-time, distance-time, and power-time curves. Perhaps he would take, for the purpose of illustration, some particular suburban line in the neighbourhood of London, and show how, by his methods, he could improve the traffic carrying power. We seem to be still somewhat far apart in our interpretation of what is meant by suburban traffic, although we endeavoured in our article to remove any misapprehension on that score by defining our views of such traffic. "U. R. B.," secure in the cloak of his anonymity, says that we are always thinking of trams and tubes, and though we may know something of both tramways and tubes, such information as we possess rather helps us to differentiate than causes us to confuse. Indeed, when we have thought over the demands of our problematical schemes, we had in our mind such questions as the moving of many thousands of passengers over lines like the Great Northern, wherein there are stations much less than a mile apart; the Great Eastern, wherein, say, between Gospel Oak and South Tottenham, a distance of four miles, there are eight stations; the Caledonian Railway, where, within the six miles between Maryhill and Rutherglen, there are twelve stations; the Lancashire and Yorkshire Railway, where, between Liverpool and Crosby, a distance of 5¼ miles, there are seven stations; the Manchester South Junction and Altrincham Railway, where in the eight miles there are four runs of less than a mile. These are not tramways or tubes, but they are examples of what has to be considered in the immediate future, and they present difficulties which cannot be removed by means of light steam engines and heavy brake blocks. Now, let "U. R. B." assume for his argument some such line; perhaps he is already connected with one; if so, his opinions will have the greater value; and we would ask him to assume further a weight of train of 172 tons, a schedule speed, including stops, of 22 miles an hour, and an average gradient of 1 in 200. We have no doubt that you will allow him space in your valuable paper, and if you will permit us to discuss the propositions he may lay down, we will undertake that we will not dabble with things which are quite outside the question. In the meantime we may say that we have not given up coasting, nor have we made any further references to economy, because there is nothing to be gained by reiteration; and what is the good of labouring the point, for "U. R. B." says: "I have, be it observed, never said that the electrical train could not do all that your correspondents expect." We did not say that we must have 4ft. per second per second retardation. We did say that, though we know of cases where the rate has been adopted, the schedule speed could not be maintained, and we made the statement as telling against "U. R. B.'s" scheme, and in no sense as part of ours. We have again looked at our letter of December 1st, and are at a loss to make out how "U. R. B." could have committed such a blunder of misreading, unless it was for the pleasure of erecting a ninepin in order that he might have the pleasure of knocking it down again. WALTER D'ALTON,

December 14th. JOHN MANNHEIM.

THE CONSERVATION OF ENERGY.

SIR,—In reply to your footnote to my last letter, "How is the energy stored up in gunpowder? Certainly not as motion. Whence does the motion come, when explosion takes place?" there seems to me to be only two explanations which will account for the sudden manifestation of energy when gunpowder is fired. Either the energy must have been present in the solids before firing, or else, during the process of combustion, it must have been obtained from some outside and unknown source. The latter theory is the one towards which I think you tended in your leader under the above heading. This theory, however, has no ground at present to stand on, and, therefore, may be neglected; and the former must, I think, be accepted until a better one is propounded.

As to the way in which this energy is held latent in the solids, I think it most probable that it is stored as motion. Maxwell's theory of heat is now, I believe, almost universally accepted, and such scientists as Sir Oliver Lodge are very near proving that all matter is in a state of minute vibration or motion, and where there is motion there is energy. At any rate, there is now no doubt that gases are always in a state of rapid vibration amongst particles of infinitesimal size. Grant for the moment, then, that the energy is present as motion—excessively minute, but excessively rapid—in the solid powder, but at present held latent by the physical condition of the powder. What will now happen if this physical condition is suddenly changed to one of much greater freedom? All the minute particles under vibration will at once extend the amplitude of their vibrations, causing rapid expansion, which after will under favourable conditions be able to do work.

One more argument. It is known that a high rate of motion gives rigidity to otherwise unstable bodies. For instance, the gyroscope; or, say, a chain revolving rapidly round one end, &c. Does not this fact point to the probability that solids are solids simply because their rate of vibration is excessively high.

All this seems to me to be reasoning "from the known to the unknown." S. W. A.

33, Victoria-terrace, Barrow-in-Furness,
December 14th.

THE MOTOR CAR IN PRIVATE LIFE.

SIR,—As your article on this subject is provoking correspondence, may it not be asked whether your article took enough count of the user of the car? For example, nine cars out of ten, ninety-nine out of a hundred may be nearer, are always driven as fast as they will go. Apply the same to a horse, and I fancy the car will be an easy winner.

Again, take the normal rough usage to which change-speed gear is subjected. The equivalent to this with a horse would be a violent kick in the ribs every time he was wanted to go faster, and jerking his tail nearly out by the roots every time he was slowed down! Here, too, the motor car is surely an easy first.

I have had to do with both horses and motor cars, and fancy that there are about three troubles with the former to one with the latter. Nearly all troubles with modern cars can be avoided by a little care and ordinary attention before the car is taken out. One would think that horses never cast shoes, shied, went down, roared, got sprained, took chills, and the hundred other ailments to which they are liable.

I have tried my hand on a variety of cars, and in my opinion, as a private owner doing my own driving, it is only old and second-hand cars that fail to reach their destinations. When a car is wanted and found not available, the failure is far more likely to be connected with the private engagements of the *chauffeur* than with the mechanism of the car. I have seen several cases of that.

I am at present the happy owner of a 10-horse (15 b.h.p.) M.M.C., and would not change her for a whole stable full of horses. Of course if people buy cheap cars they may expect trouble. I fancy that the ranks of the dissatisfied are recruited entirely from people of that sort, or those who are too lazy—or too stupid—to learn something about the mechanism of their cars. Anyway, there are really reliable cars on the market, and amongst private owners I have never yet met one who grumbled about his M.M.C. car; and I may add about the same of Panhards and Gladiators, despite the opinions of Mr. Knight on Panhard gear.

December 13th. MOTOR-MAN.

TRADE MARKS IN JAPAN.

SIR,—In your issue of September 4th (page 236, middle of third column), I notice a pertinent quotation from a British Consular report as to the "extraordinary facility" displayed by the Japanese in counterfeiting foreign trade marks and trade goods. Coupled with this is a suggestion that commercial travellers should be specially empowered, by their power of attorney, to register in Japan their employers' trade marks, if they discover, or have reason to fear, any such counterfeiting.

I do not propose to burden your columns with a disquisition upon the intricacies of the Japanese law relating to trade marks, but I wish to point out that no such addition to an ordinary power of attorney would be of any use whatever. A special, and not a general, power of attorney would have to be actually deposited, and not merely exhibited, at the Patent Bureau in connection with each application for a trade mark, and would further have to be accompanied by a certificate, or certificates, as to the nationality of the principal, or principals, on whose behalf the application was filed.

But there is a simple way out of the difficulty. Assuming that the traveller enjoys to a reasonable extent the confidence of his principals, and a moderate amount of *carte blanche* to act on his own initiative in a case of emergency, he can proceed as follows:—

(1) Through the medium and with the assistance of a resident patent agent—the traveller himself being merely a bird of passage—he applies in his own name for the registration of the trade marks covering his employers' manufactures. If his employers refuse to endorse his action, it will only cost him, up to this stage, from two to three guineas for each trade mark, and for each class of goods to which it is to be applied.

(2) He advises his principals of what he has done, and forwards to them for completion and execution certain documents drawn up by the resident patent agent. These are (*a*) an assignment by the traveller in favour of his principals of his actual or prospective rights in the said application; (*b*) a power of attorney by which they appoint the said agent as their legal representative in Japan; and (*c*) a notarial certificate of their status and nationality.

(3) If these documents are executed and returned to the agent before registration of the trade mark has actually taken place, he will probably be able to amend the application, and so save the cost of assignment.

The Government fee on registration is about three guineas, and for assignment, if necessary, about one guinea, varying slightly according to the current rate of exchange.

The total cost for each trade mark and each class of goods, including the patent agent's charges for preparation and translation of documents, will probably be from five to seven guineas, according as actual assignment is or is not required.

Numerous instances of pirated trade marks will be found in the "Notes from Japan," in THE ENGINEER, vols. lxxxvii., page 148; lxxxviii., page 282; lxxxix, page 470; and xc., page 45.

W. SILVER HALL.

Tokyo, Japan, October 31st.

RATS AND ELECTRIC WIRES.

SIR,—The following statement may be of interest to some of your readers, as showing how a fire might easily occur where an electric light installation is fitted.

The wire in question was double, twisted copper containing six strands, insulated with cotton only; it supplied the light to one of four lamps in a well-boring derrick under my charge. On the failure of the lamp I carefully examined all the fittings, and finding them in order, I had the wooden box opened which was placed over the wire as a protector. A large rat ran out, and the wire was seen to have been gnawed through in three separate places. It is difficult to say what was the attraction; the inside dimensions of the box were 4in. by 2in., so that it is hardly likely that the rat was kept a prisoner. The light had been working regularly each night for some time at 100 volts.

CLAUDE WARNER.

Roseneath, Queen's-road, Hertford, Herts,
December 13th.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

NORTHAMPTON pig iron is quoted this week 45s. 6d. to 47s. 6d.; Derbyshires, 47s. 6d. to 48s. 6d.; and Lincolns, 50s. A considerable output is being made from the furnaces. Staffordshire all-mine ordinary is quoted 60s. to 67s. 6d.; best ditto 75s. to 80s.; and cold-blast, 95s. to 100s.

In the finished iron trade the production has lately been on a large scale, and if prices were better, manufacturers would not have much to complain of. The plain black sheet firms still quote £6 15s. for doubles, for use by the galvanisers, and did not seem able to get any advance on that figure on 'Change in Birmingham on Thursday, though the margin of profit, as they did not fail to point out, is very small. Galvanised corrugated sheets were quoted £10 15s. f.o.b. Liverpool, with a moderate demand. Hoops are £6 17s. 6d. to £7 2s. 6d., and gas strip is £6 7s. 6d. to £6 10s. The demand for the last-named commodity is improving, though hardly up to the average of previous years.

Steel firms are keeping their plant well engaged upon home orders, and notwithstanding the recent severe competition from Germany and America, they have a good deal of work in hand. An accession of good orders, which has reached the carriage and wagon-building firms, is improving the call for some classes of steel and of iron for making underframes. Angles are quoted £5 10s. to £5 17s. 6d.; and girders, £5 15s. to £6 5s. German competition is less severe. Consumers appear to have satisfied their requirements for the present, and have booked in some cases into next year.

"The Mixing and Melting of Foundry Iron" was the title of a paper read before the Birmingham Metallurgical Society by Mr. Robert Buchanan. It was shown that the increase in the height of cupolas, by which economy of fuel is now obtained, was only rendered possible by the introduction of mechanical means of elevating the materials to the higher charging platforms. More than one row of tuyeres could thus be used, and melting was, therefore, not only more economical but more rapid. Various methods of introducing the blast into the cupola were shown by means of views of various types of cupolas used in the United Kingdom, Germany, and the United States. Phenomena observed by the author when melting iron containing 1 per cent. and over of manganese, were brought before the notice of the audience; and micrographs were shown of iron cast by James Watt at Soho Foundry a hundred years ago, and which, by a strange coincidence, had recently been returned to the same foundry for remelting.

The much-debated question of the duration of our coal supply has been this week once more under expert consideration, the occasion being a meeting of the Birmingham Natural History and Philosophical Society, when an interesting paper upon "Geology in Education and Practical Life" was read by Professor W. W. Watts, of the University of Birmingham. He gave reasons for thinking that our visible coal supply was coming rapidly to an end, but held that there was a great probability that there existed a deeper coal supply with which we were not yet acquainted, and which it was the province of the geologist to discover. Enormous sums of money would, in his opinion, be saved if this task of discovery were undertaken early and by competent men. The reaching of this new area of coal would postpone for centuries the exhaustion of our best source of energy. Mr. Watts is apparently quite confident—and rightly so—as to the resources of engineering skill to cope with the problems of ventilation and with some other difficulties which mining at great depths necessarily presents. Modern engineers have done a great deal in this direction, and there is every reason to believe that achievements of this order in the future will far surpass what has already been found practicable.

The special meeting of the Walsall Chamber of Commerce which has been convened to discuss the fiscal policy was held on Tuesday, Mr. J. A. Leckie presiding. Mr. T. A. Smith proposed a resolution in favour of "Retaliation and preferential and protective tariffs," and said that only that day he had received a circular from an American firm offering to supply him with pig iron at moderates rates because their trade had fallen off. The Americans had captured the coach ironmongery trade in Australia and New Zealand. Mr. Frank James seconded. Mr. E. J. Shaw moved an amendment regarding any deviation from a free trade policy as "full of the gravest dangers to our social and commercial well-being." He pointed out that this country's pre-eminence in shipping was due to free trade, which caused the shipping trade of the whole world to gravitate to its ports. Protection would, he said, enslave our people again in poverty and unremitting labour. Mr. John seconded, and the meeting was adjourned for a week, when the debate is expected to be continued.

NOTES FROM LANCASHIRE.

(*From our own Correspondents.*)

Manchester.—Except that there is some further easing down in pig iron prices, the market position here has undergone no material change during the past week. Business just moves on in much the same slow fashion recently reported, and it is only for occasional special requirements that inquiries of any moment come forward. The Manchester 'Change meeting on Tuesday brought together scarcely an average attendance, and there was only an indifferent sort of market generally. Any out-of-the-way inquiries for pig iron brought forward low quotations, and generally business is difficult to put through, owing to the low prices which here and there apparently eager sellers are prepared to quote. The continued easing down in some brands of pig iron naturally tends to encourage underquoting, but there would seem to be an impression in many quarters that somewhere near the lowest point has now been reached, and that although there is nothing in the immediate outlook to indicate probability of prices hardening, "bear" operations on any large scale are becoming, at any rate, rather a risk. Consumers in the present condition of the market are not at all eager about covering more than immediate requirements, even at the minimum current rates, and there is also with the close of the year a tendency to restrict purchases as much as possible.

The somewhat anomalous position of Lincolnshire prices, which, when a fortnight back they were reduced, put No. 3 foundry, No. 4 forge, and all the lower qualities on precisely the same basis, was, at a meeting of the makers on Friday, rectified to some extent by a further reduction of 6d. per ton on No. 4 forge, mottled, and white, leaving No. 3 foundry unchanged. This reduction, it is anticipated, may place Lincolnshire makers in a better position to meet the competition of Canadian iron, which has been offering at about 1s. 6d. per ton below local quotations. Lancashire makers have not officially followed this reduction, and nominally still quote about late rates, but as they have to compete with Lincolnshire, where business is put through practically they have to accept the same basis of prices. Derbyshire brands remain out of the market at 1s 6d. to 2s. per ton above Lancashire and Lincolnshire. Delivered Warrington, No. 4 Lincolnshire is now quoted 47s. 2d., with Lancashire ranging from 47s. 2d. to 47s. 8d.

Local and district foundry qualities remain unchanged, with not much doing. Delivered Manchester, Lancashire makers quote nominally 53s., but 6d. to 1s. under this figure would probably be accepted for anything like a good line of business. Lincolnshire remains 47s. and Derbyshire about 52s. 6d. to 53s. 6d. net, delivered here.

Middlesbrough iron has eased slightly upon last week's prices, and delivered by rail Manchester No. 3 foundry does not average more than 50s. 1d. to 50s. 7d. net. Scotch iron has also undergone some further giving way, and, delivered Manchester docks, Eglinton and Glengarnock are now quoted about 53s. 6d., with Gartsherrie about 57s net.

Reports that, owing to hardening prices in America, recent offers for the shipment of American pig iron over here are being withdrawn have had no appreciable effect upon the prices which sellers are prepared to accept. Perhaps there is a check upon a tendency to still lower quotations, if this could induce business, but otherwise the position shows no appreciable change. American pig iron, delivered Manchester docks, could still be bought at about 48s. 6d., and Canadian at from 47s. 6d. to 48s.; so far, however, the transactions put through are comparatively few and for small quantities, and what iron there may be on the way is apparently being sent across more on speculation than to meet actual sales already made.

The hematite trade remains unsatisfactory; makers continue to ease down in the prices they would be willing to accept for actual business, but are undersold in the open market, and comparatively little business is being put through. Delivered Manchester district it is exceptional where more than 61s. 6d. would now be quoted by makers for No. 3 foundry delivered Manchester district, but 60s. would represent the full average outside price.

In finished iron no material change can be reported. The Lancashire bar and hoop iron manufacturers held an informal meeting on Tuesday, when the reports as to the condition of trade were again unsatisfactory, and most of the forges continue short of work. Quoted prices remain unchanged on the basis of £6 5s., delivered stations, and £6 6s. 3d. delivered into warehouse, with North Staffordshire bars ranging from £6 5s. and £6 7s. 6d. to

£3 10s. and £6 12s. 6d., delivered here. The Yorkshire finished ironmakers have not followed the reduction in Lancashire bars, and still quote £6 10s. as their minimum, delivered into this district. The quotations of Lancashire hoop makers remain unchanged at £7 2s. 6d. random to £7 7s. 6d. special cut lengths, and 2s. 6d. less for shipment.

Throughout the steel trade business remains extremely dull. Prices have, however, now got to so low a point that this apparently is having a steadying effect upon any further easing in quotations. Continental makers of billets are, if anything, stiffening upon the low prices that were being taken a short time back, and not only are they disinclined to accept further orders unless at some slight advance, but they are not at all eager sellers, even at slightly higher rates. American billets are still being pushed on the market here, and also Canadian blooms and American sheet bars. Delivered into this district, German billets are quoted about £4 4s. for the large and £4 5s. for the smaller sizes, but these are the minimum figures. American billets are obtainable without difficulty at about £4 or less, and American sheet bars and Canadian blooms at under £4 per ton. For English-made billets quotations remain at about £4 7s. 6d. to £4 12s. 6d., delivered. In manufactured steel quotations are at a low range, representing about £5 10s. for angles; £5 17s. 6d. common plates; £6 3s. 6d. up to £6 7s. 6d. bars; and £6 12s. 6d. boiler plates, delivered in this district.

The industrial position throughout the Lancashire engineering and allied branches of trade becomes still more unsatisfactory. The employment returns of the various trades union organisations show a continued substantial increase in the number of out-of-work members, and the percentage of unemployed is now higher than has been recorded at any time during the year, or, indeed, for a very considerable time past. The serious aspect of the present situation is that it is not due to causes that are likely to be only temporary, but to a depression that has been steadily on the increase for months past, and there is no indication that the receding flow of trade has yet reached its lowest limit. The Amalgamated Society of Engineers has again to record a large increase in the number of members on donation —700 over last month, and nearly 1150 over the returns for October—which now reach upwards of 5 per cent. of the total membership, and the general secretary, Mr. G. N. Barnes, remarks that it is to be noted there has been no improvement in trade, and that the various wage movements still hang in abeyance, there being but little to report upon them. Mr. James Swift, the secretary of the Steam Engine Makers' Society, reports a further slight decline upon the trade of the month, with the percentage of unemployed now over 3½ per cent., which is an increase upon the recent returns. The United Machine Workers' Association has to record the largest percentage of unemployed, as compared with other engineering trades union organisations, and has now 6½ per cent. of its members in receipt of out-of-work support. The reports as to the condition of trade in all important Lancashire centres continue moderate, bad, or very bad, the last designation representing the situation generally throughout the Oldham and other districts closely identified with the textile machinery industries.

Mr. John Hodge, the general secretary of the British Steel Smelters' Association, reports trade all over in a not very healthy condition, with demands for reductions in wages put forward in several important districts, ranging from 10 per cent. to 25 per cent. in some parts of South Wales, whilst the Employers' Association of Steel Ingot Makers, representing the West of Scotland and the North-East coast of England, had given intimation for a reduction of 5 per cent., to take effect from the first week in January.

In the coal trade extra buying is still going on to get in supplies to cover requirements of merchants and consumers over the holidays, which in some cases will represent a stoppage of output for something like a week. This for the time being is keeping pits on full time, but does not represent any real improvement in the actual condition of trade. Prices for the most part are being steadily held to, and collieries are moving away all that they are at present producing, with here and there small quantities being filled out of stock.

The better qualities of round coal are in fairly active request for house-fire purposes, and are firm at recent quotations, but prices not more than maintained at late rates. The lower descriptions of round coal are also meeting with an increased sale for common house-fire purposes, but so far as steam and forge requirements are concerned, continue in not more than moderate request. For common house-fire coals there is perhaps a little stiffening on the very low quotations recently ruling, but for steam and forge purposes quotations remain practically unchanged on the basis of about 7s. 9d. to 8s. 3d. for common up to 8s. 6d. and 8s. 9d. for the better qualities at the pit mouth.

Engine classes of fuel still meet with a fairly ready sale, with the better qualities of slack moving away freely at full quoted rates and a tendency towards hardening in some directions, although nothing in the way of any real advance is obtainable. Medium and common sorts of slack continue fairly plentiful, but there is no large excess of supplies on the market, and prices are steady at about late rates. At the pit mouth best slack averages 6s. 3d. up to 6s. 6d. and 6s. 9d.; good medium sorts 5s. 3d. to 5s. 6d. and 5s. 9d.; with common slack about 4s. to 4s. 6d. per ton.

For shipment there has been rather more stirring and slightly better prices obtainable as compared with the very low figures recently ruling. Delivered at the ports on the Mersey average quotations have been about 9s. 3d. to 9s. 6d. for common, with 9s. 9d. to 10s. quoted for some of the best qualities of steam coal.

Coke remains without really material alteration. Foundry qualities continue in moderately active demand, and makers have no difficulty in maintaining prices at late rates. Local makers of furnace cokes report perhaps some slightly better inquiry than has been the case recently, which has given a check to the previous weakening tendency in prices; but in the Yorkshire district furnace cokes continue weak, and are not moving away at all freely.

Following the rejection by the miners of the reasonable, and to the men very favourable, terms previously agreed upon for the renewal of the Conciliation Board, mainly because they involved a reduction of 5 per cent. in wages, the decision has been given by the Conciliation Board arbitrator, Lord James, that wages are to be reduced 5 per cent. This, during the continuance of the Board, which has been extended until the end of March next, will be binding upon the miners; but there seems to be some apprehension that, unless satisfactory conditions can be agreed upon for a renewal of the Board next year, trouble may ensue with the men, who all along have expressed the strongest possible opposition to any reduction in wages whatever.

Barrow.—There is no improvement to note in the hematite pig iron trade. The demand is exceedingly quiet, and makers have a difficulty in finding a market for their output, restricted though it is. The chief direction in which iron is going at the moment is to makers of steel in the district, and when they stop at Christmas for longer holidays than are usually taken it is evident makers will either increase their already heavy stocks of iron or be compelled to damp down their furnaces until a resumption of work takes place at the steel mills. This is the attitude assumed by the Barrow Steel Company, notice having been given to the men that when the steel works stop at this week end, four of the five furnaces in blast will be damped down, and only one furnace—No. 9—left in blast. It has not been necessary to damp down the furnaces at Barrow since the great Durham strike. Then it was owing to the scarcity of coke; now it is because of the scarcity of orders. There are 24 furnaces in blast, compared with 33 in the corresponding week of last year, and at the end of this week only 20 will be working. Of these two are employed on ferro-silicon and charcoal iron respectively. Prices are easier, with makers' iron at 54s. 6d. nominal, net f.o.b., while warrant iron is at 52s. 4½d. net, cash sellers, 4½d. less buyers. Stocks of warrant iron have been reduced during the week by 699 tons, and there is now in hand 12,533 tons. Stocks in makers' hands are still very large.

Iron ore is in very poor request, and prices are weaker at 9s. to 9s. 6d. per ton net at mines for good average sorts. Spanish ores are being imported only on a small scale. They are quoted at 14s. 6d. per ton net at West Coast ports.

The steel trade is indifferently employed, and orders are held but to a very small extent. The demand for rails is quieter than it has been for some time. Heavy sections are still quoted at £5 5s. per ton net f.o.b. Plates are in moderate request, and are quoted at £5 10s., but orders are not largely held. There are better prospects for next year's trade. In other departments of the steel trade the demand is quiet, and the mills are irregularly employed. Masters find it impossible to produce steel at a profit, and have therefore given the men notice of a 15 per cent. reduction.

Shipbuilders and marine engineers are very short of work at the moment, but some new orders are in the initial stages, and will find better employment in the new year. It is reported that Vickers, Sons and Maxim have booked an order from the Canadian Government for a gunboat to protect the Canadian fisheries.

Coal and coke are quiet and at low prices, but smelters of iron are asking for lower prices still, as they find it impossible at the present cost of raw material to make a profit on their product.

Shipping is rather busier. The exports of pig iron from West Coast ports last week reached 21,492 tons—5473 tons pig iron and 16,019 tons steel, in contrast with 18,257 tons in the corresponding week of last year, an increase of 3235 tons. For the year to date the aggregate shipments have reached 829,678 tons, as against 927,974 tons for the corresponding period of last year, a decrease of 96,296 tons. Freights are low and shipping is in many cases lying idle.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

THE approaching holidays have caused the Yorkshire collieries to be somewhat brisker, and the weather having been rather sharper, the demand has increased both from the metropolitan and provincial markets. Best Silkstone, in which there is a little more doing, is selling at rates up to 13s. 6d. per ton, and Barnsley house, the quality most freely in request, fetches from 11s. to 11s. 9d. per ton in best qualities, seconds making from 10s. 6d. to 11s. per ton at the pits. A feature of the house coal trade is the large demand for common sorts.

Steam coal is being sent more freely to Hull and the other Humber ports from the South Yorkshire than from the West Yorkshire pits. Values in the open market are firm at a slight advance on the contract rate of 9s. per ton. The railway companies are receiving average supplies. Negotiations are proceeding with a view to next year's contracts. The owners in several instances are trying to get an advance on the prices now running, but the general expectation is that there will be no change on the 9s. per ton which has ruled all the year, although, of course, the coalowners are a well-united body, and, if circumstances are favourable, can generally accomplish what is reasonable.

For nuts and smudge a fair call is reported, but supplies are quite equal to the demand. There is rather less doing in coke, values remaining at 12s. per ton for best unwashed samples at the ovens. Good deliveries of gas coal continue to be made to gas companies and the gas departments of various municipal bodies.

The Dalton Main Collieries, Limited, after sinking operations extending between four and five years, have reached coal at a depth of 745 yards at Silverwood, Rotherham. The seam, which is 5ft. 9in. thick, is stated to be of fine quality. Much interest attaches to the discovery, as the new colliery is on the edge of the virgin coalfield bounded by Rotherham, Doncaster, and Worksop.

The iron and steel trades continue as previously reported, and no improvement whatever is looked for this year. Quotations for iron are exceptionally low, yet consumers do not order more than they require from week to week. In the steel trade there is equal slackness, and full time is worked at very few places. Owing to the depression in railway and similar heavy material, the Bessemer and Siemens departments are very slack.

The engineering establishments are sharing the general depression, but there are hopes entertained of an improvement early next year. The extensions of railway and mining enterprises in South Africa and other distant parts cannot be delayed much longer, and good work is anticipated from the successful use of motors for ploughing, reaping, mowing, thrashing, and other agricultural work formerly done by steam plant or horse labour. Two other orders for tramway material for Johannesburg, South Africa, have been received in Sheffield.

According to a cablegram from the Ottowa correspondent of the *Sheffield Daily Telegraph*, Messrs. Vickers, Sons and Maxim, Limited, River Don Works, Sheffield, have been awarded the contract for building the new Canadian fisheries cruiser, which is to be used secondarily as a training ship for the Canadian Naval Reserve.

The continued depression at the East End, and partially in other industrial districts of the city, has caused the Lord Mayor to open a relief fund. A deputation representing the unemployed waited upon the Lord Mayor on the 11th inst., and urged that steps should be taken. The Lord Mayor had thereupon requested the heads of the large companies and other gentlemen most closely interested to meet him in conference, which took place on the 14th inst. The result was the conclusion that the distress was, unfortunately, widespread enough to call for public support, and the Lord Mayor decided to open a fund. The opinion was freely expressed that it was preferable to find work as far as possible for those in need of it, and not to distribute money. Relief works are being started, and the names of those in want of employment are being registered at the Vestry-offices. Up to the 16th inst. £1500 was raised.

On the evening of the 12th inst., Mr. W. H. Chambers, manager of the Denaby and Cadeby Main Colliery Company, was the recipient of several presentations by the workmen and officials, on his completion of twenty-one years' association with this great colliery undertaking. The Vicar of Denaby presided over a gathering which numbered about one thousand. Mr. Chambers took over the management of the Denaby Pit in 1882. The output was then some 7800 tons per week; now it is quite double, and the output at Cadeby is close on 15,000 tons per week. Miners' wages in 1882 were 5s. 10d. a day; two years later, owing to Mr. Chambers' improved system of working, they were 9s. 3d. Mr. Chambers, in returning thanks for the gifts, stated that the loss to the company through the protracted dispute had been very heavy, and had caused the abandonment for the time being of a scheme for the provision of swimming and slipper baths, which Mr. Buckingham Pope had generously promised to furnish, providing the men took sufficient interest to pay a moderate percentage on the company's money. As soon as the exchequer was in a better state, he hoped to see the scheme accomplished.

Mr. A. L. C. Fell, general manager of the Sheffield Corporation Tramways, who has been appointed to the management of the London County Council Tramways, has been presented with a writing bureau, case of cutlery, silver entrée dishes, and butter dishes by the staff and employés he is leaving. Mr. Arthur R. Fearnley, general manager of the Birkenhead Corporation Tramways, has been recommended by the Special Sub-committee of the Sheffield Tramways Committee as Mr. Fell's successor. Mr. H. E. Yerbury, at present assistant electrical engineer, is recommended for appointment as chief electrical engineer.

NORTH OF ENGLAND.

(From our own Correspondent.)

THOUGH the iron and steel industries as a whole cannot be said to have improved, and most branches continue much depressed, yet sellers of Cleveland pig iron find the market more in their favour, and the downward movement in the prices of their iron has ceased. No 3 Cleveland pig iron has stood firm for more than a fortnight at 41s. 9d. per ton for early f.o.b. delivery, and the fluctuations in Cleveland warrants have been within very narrow limits, the highest quotation being 41s. 8d. cash buyers, and the lowest 41s. 6d. This firming up is somewhat unexpected in a month when the value of iron generally drops, and deliveries are on a comparatively small scale, and especially when it is taken into consideration that in October and November, when there were very brisk shipments, the value of iron fell somewhat sharply. Under ordinary circumstances pig iron would be declining this month, but there is a counterbalancing influence which strengthens the position of the producers; they have reduced the output by blowing out several of the furnaces, and stocks are not increasing in the hands of makers as they generally do in December, while in Connal's public warrant stores the quantity of Cleveland iron held has only been increased 224 tons this month. And yet up to the 16th the shipments were only 38,965 tons, against 64,180 tons last month and 55,592 tons in December, 1902, the deliveries to overseas ports being not much more than a third of what they were in this month last year.

Two more of the blast furnaces in the North-East of England have been blown out, Palmer's Shipbuilding and Iron Company having put out at Jarrow-on-Tyne a furnace which has been producing Cleveland iron, and another which has been making hematite, and they have now two furnaces at work out of five built, while the total number blowing in the district is seventy-six. Five furnaces have been put out within the last month, and the make is not in excess of the requirements, though these have slackened considerably.

The steadier prices of Cleveland pig iron have led to consumers being more ready to purchase for forward delivery, and there has sprung up a tolerably good inquiry for it for delivery overseas during the first half of 1904, the buyers offering, however, 6d. per ton less than for iron for prompt delivery. That concession producers are not prepared to make, though there is reason to believe that they could sell a large quantity of iron if they could see their way to accept. But they expect to be able to realise better prices in the early part of the coming year, and will not commit themselves ahead. Not less than 41s. 9d. per ton will now be taken for early f.o.b. deliveries of No. 3 Cleveland G.M.B. pig iron, though at the beginning of the week some of the second hands sold small quantities at 41s. 7½d. per ton. No. 1 realises 42s. 9d.; No. 4 foundry, 41s. 6d.; grey forge, 41s. 3d.; mottled, 41s.; and white, 40s. 9d. The price of Cleveland warrants is rather better than it was in the early part of the month, when as low a figure as 41s. 3½d. cash was reached, this being less than has been reported since the spring of 1898.

The hematite pig iron trade continues very unsatisfactory, notwithstanding that the production has been so largely reduced, not only in this district, but also in the North-West of England. The downward movement in prices is not checked, and mixed numbers of East Coast hematite iron have fallen to 50s. 3d. per ton; indeed, even 50s. has been taken by second hands this week, or 8s. less than the best price of the year. The difficulty that was reported in October and November in getting adequate supplies of Rubio ore is no longer experienced, for work is once more regularly carried on at the Spanish mines. During the first nine months of the current year the average imports of foreign ore into the Tees was 117,000 tons; but in October the quantity was 82,399 tons and in November 62,590 tons. They are on a larger scale in December, and the price has fallen back to the figure ruling before the strike, 14s. 9d., c.i.f. Tees or Tyne, being again accepted, the lowest price of the year, and 6d. below the rate reported at the beginning of the month.

The stock of Cleveland pig iron on 16th inst. was 98,728 tons, but makers have very little in their yards, nor do they intend to accumulate a heavy stock, for that always is against their interests, especially if the stock is in the public warrant stores. Large stocks mean low prices, and this was exemplified most pronouncedly in 1886, when there was 650,000 tons of pig iron in stock in this district—the largest quantity ever reported; and at that time Cleveland warrants were at the lowest price known—29s. 3d. The ironmasters now in bad times reduce the make to something like the extent of the demand, and thus do nothing to help the prices down.

There was not much demand for finished iron and steel, but it cannot be said that trade is worse than it was last week. Scarcely any of the works except the rail mills are fully employed. The depression in the plate and angle trades is so great that the steel manufacturers of this district and Scotland have decided to claim a reduction in the wages of the melters of 5 per cent. No change has been made since May, 1901. The price of steel ship plates now is £5 10s.; steel ship angles, £5; iron ship plates, £6 2s. 6d.; iron ship angles, £6; and common iron bars, £6 2s. 6d. all less 2½ per cent. f.o.t. Heavy steel rails are quoted at £5 net at works. An order for 7000 tons of tramway rails, fish-plates, &c., for the Johannesburg Municipal Tramways has been given to Messrs. Bolckow, Vaughan and Co., Middlesbrough. This is the second time this order has been on offer; it was awarded in the first instance to a Belgian firm, which, however, cried off, and it was decided to again solicit tenders and on less onerous terms than had been adopted in the first specifications.

The shipbuilding firms are doing a quiet business, and their output for 1903 will generally be much below that of the last seven or eight years. Palmer's Shipbuilding and Iron Company have just booked an order for three steamers for the Elder, Dempster Company, and have received the commission to overhaul H.M.S. Goliath, which is ordered to Jarrow for the purpose. The smiths employed at the shipyards in this district have received notices that their wages will be reduced to the same extent as the other workmen. The reduction as at first proposed was to be 5 per cent. off piece work, and 1s. 6d. off time rates, but the employers are prepared to drop the reduction on time rates, and to require only the 5 per cent. off piece work. The men are to send in their answer by Monday next, when the executive will have laid the proposal before the different branches. A settlement has not been come to yet in respect to the wages of the other men, the offer being the same to them as to the smiths. The Darlington Wagon and Engineering Company has obtained an order from the Buenos Ayres and Rosario Railway Company for 210 high capacity freight cars, and is to supply 1100 carriage wheels for the Japanese Railways.

The details of the proposed amalgamation of the Cargo Fleet Iron Company, Limited, and the South Durham Steel and Iron Company, Limited, have been made public. The ordinary shareholders in the latter company are to receive for their shares which are £1 paid 8s. per share, not in cash but in fully paid shares of the Cargo Fleet Iron Company, while the preference shares will get 12s. per share which are £1 paid, and there are besides three half-years' dividends. The capital of the Cargo Fleet Iron Company is to be increased from £200,000 to £1,500,000, and out of this £350,000 in shares will be given to the Weardale Steel, Coal, and Coke Company, in satisfaction of cash advances and interest. It has hitherto been understood that it was the Weardale Company which was erecting the new steel works at Cargo Fleet, and that they were removing their works from Tudhoe to that place. It appears that it is the Cargo Fleet Iron Company that is building the new steel works and taking over the old plant from Tudhoe.

The steam coal trade is dull, and very few of the collieries are kept in full operation; yet even then the production is in excess of requirements, and there are stocks at some of the pits. Consumers will not pay as high figures for next year's delivery as they are giving under existing contracts. The tenders sent in to the North-Eastern Railway Company for next year's supply were on the basis of the present year's prices; but the company promptly refused even to consider such quotations, and amended tenders are being sent in. For best steam 9s. 6d. per ton f.o.b. is now asked, with 8s. 3d. for seconds and 4s. for smalls, the last named

figure being specially poor. The deliveries of gas coals are heavy, and prices are well maintained, best at 9s. per ton f.o.b., and seconds at 8s. 9d. Coke is easier, notwithstanding the near approach of the holidays; but by the blowing out of furnaces in this district and on the West Coast the consumption has been a good deal reduced. At the same time, however, the output of coke has also been curtailed. Foundry coke is at 15s. 6d. per ton f.o.b., and medium at 14s. per ton delivered at the furnaces here; but sales at less than the latter figure have been reported.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THERE has been, on the whole, a slightly better feeling in the Scotch iron trade this week, although it cannot, unfortunately, be said that business has made any substantial improvement. At the end of the last week the warrant market firmed up to some extent, in sympathy with the state of metals. This week some confidence has been given to operators by rather more favourable cable reports from the United States. These latter are to the effect that the reduction of output in America is already making itself felt to such an extent that trade is assuming a firmer tone on the other side.

A report was current two or three weeks ago that some American goods had been sold here, including a parcel of brass bearings, at a price quite advantageous to the Scotch purchaser. It is now stated that when the buyers desired to repeat their purchase they were informed that the sellers were out of the market. Moreover, it is reported that a decidedly better feeling is springing up in American iron and steel circles, giving rise to the expectation that home wants may yet prove sufficient to avert the threatened extensive shipments of United States material to this market.

The Glasgow pig iron market was exceptionally idle on Monday, there being practically nothing doing in any class of iron. On the following day the market showed a good deal of animation, due, it is thought, to the more satisfactory American reports noticed above. Cleveland warrants were done at 41s. 7d. for cash, 41s. 7½d. for delivery in twenty-one days, and 41s. 9d. to 41s. 8d. one month. There has been nothing doing in Scotch warrants, which are quoted nominally 43s. 9d. Cumberland hematite warrants are likewise quoted, without recorded business, at 52s. 3d. per ton.

The prices of Scotch makers' pig iron have been tending easier. G.M.B., No. 1, is quoted at Glasgow 50s., No. 3, 49s.; Monkland, No. 1, 51s., No. 3, 49s; Wishaw, No. 1, 51s. 6d., No. 3, 50s.; Carnbroe, No. 1, 52s. 6d., No. 3, 50s.; Clyde, No. 1, 59s., No. 3, 52s.; Gartsherrie, No. 1, 59s. 6d., No. 3, 52s. 6d.; Summerlee, No. 1, 62s. 6d., No. 3, 55s. 6d.; Langloan, No. 1, 70s. 6d.; No. 3, 57s.; Coltness, No. 1, 71s. 6d., No. 3, 56s.; Glengarnock at Ardrossan, No. 1, 59s.; No. 3, 52s.; Eglinton at Ardrossan or Troon, No. 1, 52s., No. 3, 49s.; Dalmellington at Ayr, No. 1, 51s. 9d., No. 3, 48s. 6d.; Shotts at Leith, No. 1, 62s. 6d., No. 3, 56s.; Carron at Grangemouth, No. 1, 62s. 6d.; No. 3, 55s. 6d. per ton.

There is a quiet business in Scotch hematite, which is quoted by merchants 56s. per ton for delivery in railway trucks at the West of Scotland steel works.

In the past week the stock of pig iron in the Glasgow warrant stores was reduced only 30 tons, and the total stock is now about 9400 tons.

So far the output of pig iron in Scotland has been well maintained, there being 86 furnaces in blast, compared with 87 at this time last year. Of the total, 40 have been making ordinary, 40 hematite, and 6 basic iron. It is reported that the furnaces now in blast at Glengarnock Ironworks, six in number, are to be put out at the beginning of the New Year holidays, the intention being to close them down for at least a month, while the time of starting them again will depend on the condition of trade.

The shipments of pig iron from Scottish ports in the past week were comparatively small, amounting to only 4466 tons, compared with 7680 in the corresponding week of last year. There is now a total decrease in these shipments since the beginning of the year of upwards of 50,000 tons.

The arrivals of Cleveland pigs at Grangemouth in the past week amounted to 11,130 tons, being 3033 tons more than in the corresponding week. There is a total increase in these arrivals since the beginning of the year of 87,526 tons.

Reports with reference to the finished iron and steel trades are not at all cheering. It is hoped that some favourable change may come early in the year, but there are not at present many points of importance that could be cited in support of such a view. Steel ship plates are quoted £5 5s. 6d. to £5 7s. 6d., but it is reported that business has been done as low as £5 2s. 6d. Angles are quoted £4 15s. and bars £5 15s., all these figures being subject to the usual 5 per cent. discount for cash in one month.

There is a fair business in the coal trade. The coal shipments from Scottish ports exceeded those of the preceding week by upwards of 30,000 tons, and are quite good for the season of the year. Shipping prices do not this week show any variation. For home use there is a good demand for household coal at steady prices, while splint coal is selling well, and all kinds of manufacturing coals are fairly active.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

THE stop-day trouble is shown to have been of a costly nature. The Powell Duffryn Collieries have been selected as affording a basis, and their losses are stated to be £5,825,141. Appeal is to be made to the House of Lords against the late decision. An important meeting of one of the best institutions that has been founded in connection with the colliers—that of the Miners' Provident Society—was held in Cardiff on Saturday, Sir W. T. Lewis presiding; and he was gratified in announcing that the Registrar of Friendly Societies had granted a certificate for the renewal of their scheme for a further period of five years, modified by increasing the disablement pay to the workmen from 10s. to 12s. per week during the first thirteen weeks, with a reduced contribution from employers of 4d. per week per workman in lieu of 5d. During the continuance of the present scheme 400 pensions to the aged have been granted, involving the expenditure of £30,000.

Mr. D. A. Thomas gave his opinion of the present state of the coal trade this week at a political meeting in Monmouthshire. He "thought the reduction of 5 per cent. to colliers was a mistake, and that it had been more than given away lately in lower contracts. This was due to a lack of cohesion amongst coalowners, who were tumbling over one another to secure contracts." Mr. Thomas instanced the Transatlantic for about 300,000 tons, which had been secured at low rates. He also referred to the coal tax, "which had opened the way for keen German rivalry. Since the imposition, hundreds of thousands of tons were going into competition with Welsh over the French border." His advice to colliers was to "put by their savings for a rainy day. Their average was now higher than it had been for ten or twenty years." With reference to the French contract, I hear that the Ocean, Cambrian, Naval, and Penrikyber figure amongst those who have obtained a share; prices not yet stated. Messrs. Cory Brothers have the Brazilian railway contract—120,000 tons.

There has been a larger arrival of tonnage at Cardiff this week, and prices are firmer. Last week despatches were fewer, and there was a degree of weakness on the coal market. It was stated that in some cases forward steam coal had been sold, Admiralty selection, at 13s. 6d. Ruling prices this week, Cardiff, are as follows:—Best steam, 14s. to 14s. 6d.; seconds, 13s. 3d. to 13s. 9d.; drys, 14s; best smalls, 7s. to 7s. 6d.; seconds, 6s.; other kinds from 5s. 6d. Monmouthshire semi-bituminous best, 12s. 9d. to 13s.; best ordinaries, 12s. 3d. to 12s. 6d.; seconds, 11s. 3d. to 11s. 6d. House coal, 16s. 6d. to 17s.; best ordinaries, 14s. to 15s.; seconds, 10s. 6d. to 11s.; No. 3 Rhondda, 14s. 9d.; small, 9s. 9d. to 10s.; No. 2 Rhondda, 11s. to 11s. 3d.; small from 6s. 6d. Coke, 17s. to 23s. Pitwood still firm, 19s. 6d. to 20s.

Newport quotes best semi-bituminous coal at 12s. 9d. Swansea best steam at 14s. 6d.; bunkers at 9s. 6d.; small, 6s.; house coal, 15s.; anthracite malting from 17s. 6d. to 20s.; best large, 10s to 12s.; cobbles, 19s.; nuts, 20s. to 22s.; peas, 11s. 6d.; culm, 5s. 9d. Patent fuel is at 13s. to 13s. 6d. Cardiff prices, including tax, is 14s. 6d., and for forward sales firm contracts have been large.

The Swansea coal trade in bituminous districts has shown no improvement, and it is openly stated at Swansea that there are no good signs either at Foxhole or Guerets. A new company is forming to work Caepridd and Park Pit. During last week Swansea exported 42,000 tons coal, France took close upon 18,000 tons, South Africa 1050 tons, Germany 3705 tons. Only 4000 tons patent fuel left port.

In many colliery and ironworks offices the compilation of statistics is going on, but it will not be until a little way in the new year that exact totals will be obtained. I see from "preparations" that 97,894 tons of steel have been despatched from Wales up to and including November. Cardiff during the ten months sent 15,448,205 tons of coal, 48,519 coke, and 324,659 patent fuel, Newport 3,513,328 tons of coal, 13,199 coke, and 37,200 tons of patent fuel. Swansea 1,991,388 coal, 16,820 coke, and 430,311 patent fuel. Swansea maintains its premiership in fuel, and figures well in steel, owing to Llanelly Harbour not being opened. The smaller ports also come in for notice. Port Talbot in the ten months despatched 6199 tons of coal, 16,175 coke, and 82,183 patent fuel, Neath 271,127 coal, Llanelly 266,175 coal, and 11 coke. Taking the month of November alone into consideration for comparison purposes, I find that in foreign and coastwise Cardiff shows an increase in coal shipments, Newport an increase in coastwise, and Swansea in coastwise, Port Talbot a decline foreign, but an increase coastwise.

The iron and steel trades continue in much the same condition. Pig weaker, orders finished steel dull. Heavy cargoes of billets have come in to Newport from Antwerp, and a vessel engaged in the carrying trade reports "no dividend;" it is evident that rates and freights are cut very fine. A good reciprocal trade, states a critic on the condition of things, might rectify this. No American steel cargoes are yet reported at Swansea. In the Monmouthshire and in the Swansea district the evils of dumping are boldly stated. A mill at Ebbw Vale is stopped. In the Cyfarthfa district slackness alternates with partial activity, rails and fish-plates are being worked off this week. Dowlais works are fairly employed. In the Swansea district some departments at Landore are under notice. Works hitherto supplying tin bar to the tin-plate manufacturers report stagnation. The probabilities are that bad times are ahead for workers in pig iron, steel smelters, and bar mill hands. In the tin-plate trade there has been a good deal doing in all but the finishing departments. Their dulness has been very visible. Russian business: sheets, various, has been active. Tin is at £125, and tells severely on makers, as the prices obtained are inadequate though firmer.

Circular discs are in demand. Most mills have been busy. Last week was a brisk shipping week. Nearly 80,000 boxes were shipped, and as only 65,210 boxes came from works, though a good make, stocks are down to 122,340 boxes. Mond nickel works have been busier, and the copper works more employed than usual, but the foundries in most directions are slack. Probably the partial inactivity at this and other industries is to be attributed to the coming holiday season. At Briton Ferry smelting furnaces are busy and mills also turning out well, but here again the outlook is bad. Notices have been posted at the Villiers works that contracts will cease in twenty-eight days. Probably this may only be temporary, as a prelude to other arrangements.

Though shipbuilding at Cardiff is yet regarded as far away, the experiences of firms in operating in that direction having told upon their dividends, the capacity of local works to turn out steel sheets for ships and other uses has been well demonstrated.

Last week over seventy members of the Bristol Channel Committee of the Institute of Marine Engineers visited Cardiff and inspected the new docks, the steel for which was all supplied by the Dowlais Cardiff works, and regarded as a most creditable production. The caisson is not yet completed, but stands nearly 60ft. in height, and was voted by the visitors as imposing. Its length is 96ft. 8in.; beam, 34ft.; depth, 48ft. 6in.; breadth of the roadway deck, 13ft. It consists of four water-tight decks in addition to the roadway, and will weigh, with the ballast, over 900 tons. With all the ballast tanks empty, it will float at a draught of 18ft. The caisson contains about 500 tons of steel, and the number of rivets 100,000. The designers were Mr. Geo. Neill Abernethy, C.E., London, and Mr. Henry S. C. Ree, C.E., engineer to the Cardiff Railway Company, in consultation with Sir E. J. Reed, K.C.B.

At the luncheon, after the meal was ended, excellent testimony was given by some of the principal visitors to the admirable manner in which the work had been carried out. Mr. Aisbitt, Salvage Association, commented upon the perfect character of the electric arrangements, all the machinery, except the pumping, being driven by electric power. Mr. Munro, Barry Graving Dock, was especially struck with the pumping machinery. He considered the pumps the best equipped and most economically worked in the district.

At Gorveinion Colliery a powerful winding engine has been placed calling for notice, having a 36in. cylinder, a 6ft. stroke, and an 18ft. drum. The colliery has been sunk to the 4ft., engine manufactured by Longbotham and Co., Wakefield, erected by Barraclough and Son, Barnsley. Mr. R. Abraham is the resident manager and engineer, and the colliery, when completed, will be one of the largest in the western district.

The Taff Vale motor is to have business trials forthwith to Penarth, &c.

A large cargo of steel rails left port this week for Natal. Heavy rails are quoted at £4 10s.

Another good order for patent fuel, 6000 tons, has been placed by Russia.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

FROM week to week the same unfavourable reports have to be given of the iron market over here, the absence of any real improvement being the principal feature in all trades. Competition continues keen and work is unevenly divided; only in exceptional cases have manufacturers been able to secure sufficient contracts to keep their plant fully employed.

In Rheinland-Westphalia the tone in the iron industry shows weakness and uncertainty, which is partly caused by an abatement in the demand on foreign accounts, and also because the forming of the Steel Convention, which would be of much importance with regard to other syndicates, is generally considered as doubtful now. Low prices have failed to attract customers, and very few big sales have been effected. Especially in finished iron competition is keener than ever. An altogether insufficient employment continues to be reported in the plate and sheet trade, and bars, though in fair request, are depressed as regards quotations. Girders have remained in tolerably good demand. A fairly satisfactory condition prevails in the raw iron business, where basic and foundry pig are actively called for, while Bessemer is a trifle neglected

Silesian ironmasters are doing a fairly good business on foreign account, and inland demand likewise has been moderately active, at least for rails and girders. In the pipe department a lively trade is being done, while in the plate and sheet trade production is much higher than consumption. The Königs and Laura-Hütte, in Upper Silesia, are going to enlarge their Martin steel works by the building of three blast furnaces.

For coal a good inquiry comes in, both in Rheinland-Westphalia and in Silesia, and coalowners are fairly content with the trade that is doing generally, although in the last-named district consumption at this time last year was higher than it is now. However, last year's more active trade in coal was due partly to the colliers' strike in America and in France, and also to the cold weather that prevailed for some time before Christmas. The mild weather of the past week will, in all probability, cause some further weakness in the business for house fuel. A good trade in coke is done from Silesia to Russia and to Austria-Hungary.

The business in coal in Rheinland-Westphalia has presented a somewhat firmer aspect during the past week, deliveries in house coal being pretty large. Coke, too, is brisk of sale; especially the blast furnace and foundry sorts meet with very good demand.

With regard to employment nothing has altered in the Austro-Hungarian iron industry; prices have here and there been raised, which is somewhat strange, considering the small amount of orders that hitherto makers have been able to secure. Thus sheets were raised one crown per 100 kilos. for Vienna, and half-a-crown for Bohemia. Also heavy plates have been advanced one crown for Vienna and for the other districts. The locomotive shops, which are but poorly occupied at present, are very much looking forward to the large orders that the South Railway is going to place in the course of next year. There is talk of 10 passenger cars for express trains, 12 ordinary passenger cars, 2 conductor's cars, 110 covered and 55 open load wagons, the cost being estimated at 1,500,000 crowns. Also for the Hungarian Railway net wagons are going to be purchased, and the shops of Ringhofer, Weitzer, Nesselsdorf and Simmering will be taken into consideration when these wagon orders are being placed. Generally, the situation of the machine industry in Austria-Hungary is going from bad to worse.

For coal and coke a moderately good inquiry comes in on the Austro-Hungarian market, quotations being the same as before; the demand for gas coal has been rising of late.

Business transactions in the Centre have been increasing, also in the Nord Department a good trade was done, and the French iron market altogether shows more liveliness than formerly.

The tendency is firm on the French coal market; stocks in house coal are fairly large still, while a satisfactory business is done in engine fuel. Only in the Centre demand is slack, and the working hours, therefore, had to be reduced in some instances.

German competition has been the cause of a considerable depression in quotations in the Belgian iron industry; the position of the rolling mills is particularly unfavourable both as regards quotations and the number of orders obtained. The girder trade is very quiet, and finished articles, generally, somewhat dull.

Engine coal sells briskly in Belgium, and stocks are small, whereas the consumption for house fuel is less active than it ought to be at this time of the year, and very sharp frosts would be required to cause a decrease in stocks. Prices are moderately stiff.

The production of pig iron in Germany, including Luxemburg: is officially stated to have been, for October of present year, 869,463 t., of which 161,509 t. were foundry pig, 39,316 t. Bessemer, 561,010 t. basic, 47,191 spiegeleisen, and 60,234 t. forge pig. Output in September of present year was 848,889 t.; in October, 1902, only 742,502 t. were produced. From January 1st to October 31st of present year 8,394,056 t. were produced, against 6,917,737 t. for the corresponding period the year before.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, December 2nd.

THE announcement of receiverships in a number of the larger industrial corporations has been reflected in the stock markets in a declining tendency in stock quotations. The passing of dividends in two or three instances has had an unfavourable effect. Railroad securities, on the other hand, are in many instances manifesting strength, and there is a fair demand for the better classes of securities. The prosperous condition of the railways is referred to in the stock market as evidence of soundness, and the increasing volume of traffic for this season is also pointed out as a strong reason why a speculative movement on the part of investors at this time would be wise.

The steel industry in a general way shows some evidences of revival, but it is confined for the most part to the smaller buyers, who for a year past have been purchasing for immediate needs only. From one to two years ago the general habit was to carry as large stocks as it was possible to carry, but within twelve months the evidences of accumulation due to expanding capacity have warned consumers to adhere to a more cautious policy, which they have stubbornly pursued, and are even now in no humour to relinquish.

Some very vigorous efforts are now being made to find an outlet for steel rails and railway material abroad, and a good deal of business has been quietly done in this direction. The agents who are engaged in this work of drumming up Transatlantic business, make reports which afford the steel interests on this side much encouragement. Freight rates on steel rails from the mills to the coast have been reduced, so that it is easier now to secure new business.

The production of pig iron has been very greatly decreased, and it would appear that another of those violent reactions which characterise American markets might be encountered unexpectedly. The restriction policy is being vigorously followed up, but as yet the influence of this course upon the market is not apparent. Buyers are not taking alarm, but are still purchasing only as they are obliged to.

Exports of agricultural products are increasing, and opportunities are opening up for still farther increases. Agriculture is being stimulated by opportunities for disposing of American cereal products in many parts of the world. The Pacific Coast trade shows the most encouraging signs of expansion. The railroads with termini on that coast are furthering shipbuilding schemes in order to control water transportation facilities across the Pacific.

The Gulf ports, such as Galveston, New Orleans, and Mobile are also improving their harbour facilities under encouragement of improving trade, and also because of the efforts made by some of the leading railway systems to develop trade possibilities at these ports. The outcome probably will be the diversion from New York City of considerable business which has heretofore found an outlet through this port. This tendency does not escape the observation of the mercantile and financial interests here, and it is intended to protect New York City as far as possible by the construction of the much-talked-of ship canal from Albany to Buffalo. This, however, does not affect the large area of the United States, whose natural outlet is to the southward. The south-western section of the United States has for the past few years been developing more rapidly than the north-western, because of the climatic attractions and unusual fertility of soil. The drawback in that section, as well as in the far west, is the lack of water, but the Government has recently taken action for the reclamation of vast regions of country by impounding the waterfall in the mountain ranges. For this purpose some 25,000,000 dols. will be available within eight or ten months.

THE mineral borocalcite furnishes the base of the greater part of the borax consumed in Europe. Fifteen parts of finely crushed ore with sixty parts water, eight parts sodium bicarbonate and two of caustic soda are boiled in a steam-heated boiler about three hours. It is then filtered and crystallised, yielding crystals of borax. It is estimated that 100 lb. of borocalcite will yield from 100 lb. to 105 lb. of crystallised borax.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents.

Application for Letters Patent.

☞ When inventions have been "communicated" the name and address of the communicating party are printed in italics.

2nd December, 1903.

26,293. LENSES, C. G. Woodhead, Hereford.
26,294. CLEANSING SOILED LINEN, W. H. Read, Birmingham.
26,295. NUMBERING MOTOR VEHICLES, D. E. Brown and C. H. Worsnop, Halifax.
26,296. PLAYING MUSICAL INSTRUMENTS, J. Neumayer, L. Hessling, and Westdeutsche Export and Import Company, Limited, Germany.
26,297. PULLEYS and BELTS, P. R. J. Willis.—(*J. Weichhart, United States.*)
26,298. MANUFACTURE of BOOTS, &c., R. Chambers, Leicester.
26,299. TRANSMISSION of POWER, A. C. L. Back, Plymouth.
26,300. SHUTTLES for LOOMS, G. W. Singleton and T. Smith, Manchester.
26,301. LOOM SLAYS, T. Pickles, Manchester.
26,302. EMERY GRINDING MACHINES, A. A. Tattersall, Glasgow.
26,303. TREES for BOOTS and SHOES, J. Greenwood, Halifax.
26,304. OVENS, R. K. Crosland, Halifax.
26,305. ELEVATING CROPS into VEHICLES, T. Stewart, Glasgow.
26,306. COW-MILKING APPLIANCES, R. Wallace, Glasgow.
26,307. ELECTRICAL CONNECTION, F. J. Turquand and J. F. Wakelin, London.
26,308. COMBINATION HEEL PIECE for BOOTS, E. J. Price and T. Carey, Cardiff.
26,309. STEAM-RAISING APPARATUS, G. Hughes, Manchester.
26,310. FUNNEL EVAPORATOR, R. Wilson, London.
26,311. ADHESIVE PAPER LETTERS, W. H. and F. Pacey, Sheffield.
26,312. CORLISS VALVE GEAR, J. Horsfall, Halifax.
26,313. AUTOMATICALLY EXTINGUISHING OIL LAMPS, H. T. Fothergill, Glasgow.
26,314. MAKING BASIC FERRIC SULPHATE, W. Garroway, Glasgow.
26,315. OAT GRADING MACHINES, A. Mather, Glasgow.
26,316. VARIABLE SPEED CLUTCHES, S. Bohn and R. Speirs, Glasgow.
26,317. CYCLISTS' WATERPROOF APRON, S. B. Seropian, Nenagh, Ireland.
26,318. ADJUSTABLE SCALE for SCRIBING BLOCKS, W. H. Glaser, Manchester.
26,319. SELF-READING SCRIBING BLOCK, W. H. Glaser, Manchester.
26,320. PHOTOGRAPHY, G. and W. B. Cowcher, Ebley, Glos.
26,321. PNEUMATIC TYRES, F. W. Rushbrooke and F. D. Tippets, London.
26,322. PENCIL SHARPENER, H. F. Drader, London.
26,323. LINE GUIDER, E. Maurice, London.
26,324. ARRANGING TURBINES, P. Ferguson, London.
26,325. PHONOGRAPHS, B. E. Edwards, Thornton Heath, Surrey.
26,326. PORTABLE CULINARY BOXES, A. Baudoin, London.
26,327. WET GAS METER, J. Hayes, sen., and J. Hayes, jun., Liverpool.
26,328. NON-REFILLABLE BOTTLES, W. H. Nosworthy and S. J. Prescott, London.
26,329. DOOR ALARMS, J. Wagner, E. T. and H. G. Wright, Ontario, Canada.
26,330. COOLING APPARATUS, H. R. Gore and W. S. W. Fraser, London.
26,331. ENVELOPES, W. Pietsch and A. Beccard, London.
26,332. WIND INSTRUMENTS, A. Zuleger, London.
26,333. BOOT PEG RASPING MACHINE, A. Bartels and J. Knops, London.
26,334. MOVING BOTTOM BRACKET for CYCLES, A. E. Miles, London.
26,335. BOOTS and SHOES, G. H. Ellis, Fleet, Hants.
26,336. GAS GENERATING APPARATUS, W. P. Warren, London.
26,337. STRAW and PLAIT EMBOSSING MACHINE, S. B. Hubbard, London.
26,338. DEVICE for MOTIVE EXERCISES, J. I. Sandmann, London.
26,339. MUSIC RECORDING APPARATUS, G. E. Prince, London.
26,340. REMOVING NICOTINE from TOBACCO, K. Wimmer, London.
26,341. CONVEYING APPARATUS, S. E. Page.—(*The Robins Conveying Belt Company, United States.*)
26,342. LOCKS, R. W. H. Rodney, Birmingham.
26,343. WINDOW SASH FASTENER, R. W. H. Rodney, Birmingham.
26,344. CLINOSTAT, W. R. Bawden, London.
26,345. APPARATUS for PREPARING GLASS, G. Poncelet, London.
26,346. CONVEYING MECHANISM, D. Cave, London.
26,347. ARTIFICIAL FUEL, The Graigola Merthyr Company, Limited, F. C. Yeo, and S. L. Gregor, London.
26,348. AUTOMATIC COUPLINGS, C. M. A. and F. V. Culverhouse, London.
26,349. SHACKLES, E. Wolfgang, London.
26,350. DAYLIGHT REFLECTORS, J. Cossmann, London.
26,351. HOE for POTATOES, H. Lehr, London.
26,352. VACUUM ARC LAMPS, H. Emonds, London.
26,353. TIE CLIP, H. E. Humphry and W. F. Brown, London.
26,354. UNDERWEAR, M. E. Clare, London.
26,355. FASTENING DEVICE for BOOTS, E. M. Webb, London.
26,356. FIRE ESCAPE, E. I. Dumville, London.
26,357. CORK DRAWING MACHINE, W. Fraser, Manchester.
26,358. VARIABLE SPEED GEAR, The Tangye Tool and Electric Company, Limited, and W. H. Bailey, London.
26,359. DOWEL PLATES, E. Preston, London.
26,360. RECOVERING ALCOHOL from WASTE PRODUCTS, C. Tuckfield and W. G. de F. Garland, London.
26,361. WHEELS for ROAD VEHICLES, J. L. Brooke, London.
26,362. SHACKLE HOOKS, W. Robson, London.
26,363. METAL ENAMELLING FURNACES, H. H. Cunyngham, London.
26,364. PROPELLING SLEDGES, I. Cop, London.
26,365. COPYING MACHINE, H. J. Haddan.—(*E. Lichtenstein, Germany.*)
26,366. SAPONIFYING PETROLEUM, F. J. Lothammer and C. Trocqueuet, London.
26,367. ENGINES, A. G. Fry, London.
26,368. WORKING HYDRAULIC PRESSES, J. W. Brown, London.
26,369. WORKING LIFTS, J. W. Brown, London.
26,370. RENDERING TUBULAR CONDUITS FLUID-TIGHT, E. Fenderl, London.
26,371. OVERCOATS, J. Sanderson and F. Newell, London.
26,372. CELLS for STORAGE BATTERIES, H. Soar and W. H. Fellows, London.
26,373. VALVE MECHANISM, J. Filts, London.
26,374. PNEUMATIC TIRES for WHEELS, J. C. N. Fomeloy, London.
26,375. HARD SOLDERING ALUMINIUM, C. and L. Michelis, C. Kruse, and O. Kuhn, London.
26,376. HARD SOLDERING CAST IRON, C. and L. Michelis, C. Kruse, and O. Kuhn, London.
26,377. ROTARY ENGINES, A. Hula, London.
26,378. ELECTRIC MOTORS, J. Y. Johnson.—(*The Elektrizität Aktien Gesellschaft vormals W. Lahmeyer and Co., Germany.*)
26,379. BLACK SULPHUR DYES, G. W. Johnson.—(*Kalle and Co., Germany.*)
26,380. ELECTRIC SAFETY FUSES, J. Y. Johnson.—(*The Elektrizität Aktien Gesellschaft vormals W. Lahmeyer and Co., Germany.*)
26,381. LEGGINGS, R. Hall, jun., London.
26,382. PORTABLE TELESCOPES, W. F. Stanley and W. F. Stanley and Co., Limited, London.
26,383. REPRODUCING MECHANICAL MOTIONS, W. H. Newman, London.
26,384. WATER-CLOSETS, H. E. Baden, London.
26,385. APPARATUS for CALCULATING WAGES, J. P. K. Clark, London.
26,386. NOZZLES for DISCHARGING LIQUIDS, E. Shaw, London.
26,387. No application for this number.
26,388. CONSTRUCTION of WALLS, A. Holstead and J. Roberts, Hull.
26,389. COLOUR PRINTING, F. von Eulenfeld, London.

3rd December, 1903.

26,390. SPEED INDICATOR, M. A. Wier, Kingston-on-Thames.
26,391. EXTRACTING METALS from ORES, P. J. Ogle and The Rapid Cyanide Treatment, Limited, London.
26,392. SEPARATING SOLID and LIQUID PARTICLES, P. J. Ogle and The Rapid Cyanide Treatment, Limited, London.
26,393. DETACHABLE MUDGUARD STAYS, A. Recce, Birmingham.
26,394. REVOLVING HEEL PADS, C. F. Wood, Enfield Lock, Middlesex.
26,395. TEMPLATE for MITRING, H. Parsons, Birmingham.
26,396. LOADING MAGAZINES for CAMERAS, T. J. Denny, London.
26,397. SAFETY KEY for MACHINERY, C. and G. Dodge, London.
26,398. BRICK-DRYING CAR, M. Morris, Gateshead-on-Tyne.
26,399. WRITING MUSIC for PIANOFORTES, J. Hill, London.
26,400. SPINNING MACHINERY ROLLERS, J. Clad and W. Ambler, Keighley.
26,401. PROTECTORS for BOOT UPPERS, R. J. Footner, Manchester.
26,402. BOTTLE-WASHING MACHINES, S. Hinchliffe and W. Beetham, Manchester.
26,403. PRODUCING COMBUSTIBLE MIXTURES, J. Clay, Liverpool.
26,404. REED-MAKING MACHINERY, H. Tetlow and C. Aplin, Manchester.
26,405. GIRDERS or BEAMS for BUILDINGS, J. Hazzlewood, Manchester.
26,406. MATTRESSES or PALLIASSES, P. Jenkinson, Derby.
26,407. FUEL VAPORISER, H. L. P. Boot and D. Smith, Tunbridge Wells.
26,408. MEASURING GROCERIES and DRY GOODS, T. Parkinson, Halifax.
26,409. COMPOUND YARNS or THREADS, J. R. Brogden, Halifax.
26,410. GRATES, J. Briggs, Bradford.
26,411. MOTOR CYCLES, E. Banks, Nottingham.
26,412. CUTLERY CASES, W. Bower and J. W. Nield, Sheffield.
26,413. MOVING DRIVING BELTS, E. Garlick and J. Parkin, Sheffield.
26,414. LOCKS, F. D. Ward and C. E. P. Gabriel, Birmingham.
26,415. AERATED LIQUID BOTTLE OPENER, G. Bottely, Birmingham.
26,416. GAS PRODUCERS, D. Colville and Sons, Limited, and C. Hislop, Glasgow.
26,417. GENERATING MECHANICAL POWER, G. Ulmer, London.
26,418. COFFINS for INDICATING BURIAL ALIVE, E. J. Jephson, London.
26,419. ADMINISTERING ANÆSTHETICS, E. W. Poole, London.
26,420. ATTACHED DOG ENDS for FENDERS, P. E. Bryant, Birmingham.
26,421. TRANSMISSION of POWER, F. H. and C. Hall, Birmingham.
26,422. MAKING UPHOLSTERED CHAIRS, J. Osborne, Bristol.
26,423. SMOKE DESTROYER, L. Gallimore and D. Hume, Musselburgh, Midlothian.
26,424. SPRING WHEEL, D. C. Master, Cirencester, Glos.
26,425. STRAIGHTENING ANGLE IRONS, N. S. Arthur, Glasgow.
26,426. UMBRELLA or SUNSHADE STICK, J. W. Penicud, Cambridge.
26,427. ELECTRIC CONTROLLING GEAR, A. Eckstein and A. E. Angold, Manchester.
26,428. LETTER CARDS, I. Joseph, London.
26,429. VARIABLE SPEED PULLEY, C. Payne, Cranbrook, Kent.
26,430. ANTI-VIBRATORS for INCANDESCENT GASLIGHTS, W. Beal, Birmingham.
26,431. PASTEURISING DRINKS in BOTTLES, E. Luhmann, Berlin.
26,432. SCREWS, A. J. Lehmann and M. C. and F. W. Harley, Liverpool.
26,433. INCANDESCENT BURNER for LAMPS, O. Arendt, Berlin.
26,434. MUSICAL INSTRUMENTS, C. J. Winter, London.
26,435. ELECTRICALLY-ACTUATED MECHANISM, L. Jacot, London.
26,436. PARCIPITATION of METALLIC COMPOUNDS, A. Warne, London.
26,437. MANUFACTURE of ICE for PRESERVING GAME, E. Markmann, London.
26,438. APPARATUS for LOCKING RAILWAY CARRIAGE DOORS, J. Armitage and A. Rhodes, Sen., London.
26,439. SMALL FIRE-ARMS, T. Perkes, London.
26,440. INTERNAL COMBUSTION ENGINES, T. Hallewell, Coventry.
26,441. MANUFACTURE of BRUSHES, W. A. Weir, London.
26,442. CONVERTIBLE BICYCLE RESTS, T. Holder, London.
26,443. SEWING CABINETS, O. Yates, London.
26,444. GEARING having VARIABLE VELOCITY, A. W. Boon, London.
26,445. GENERATING CARBONIC ACID GAS, H. Swales and H. S. Elworthy, London.
26,446. OUTSIDE BLINDS or AWNINGS, L. Négre, London.
26,447. DEVICE for RETAINING CORDS, R. Poore, London.
26,448. "DUST SHIELD" for MOTOR CARS, G. H. and J. A. Turnock, London.
26,449. FORM of AMMETER and VOLTMETER, W. J. Bell, London.
26,450. ORNAMENTAL HAIR COMB, C. J. Flook, Rickmansworth, Herts.
26,451. FAST-FINISHED EDGES and SCALLOPS, J. W. Attenborough, Nottingham.
26,452. SOLDERING ALUMINIUM, J. D. Fulcher, London.
26,453. BICYCLES, A. E. A. Müller, London.
26,454. ELASTIC FLUID TURBINES, W. Le R. Emmet, London.
26,455. ELASTIC FLUID TURBINES. The Warwick Machinery Company, Limited.—(*The General Electric Company, United States.*)
26,456. INSULATING ELECTRIC CONDUCTORS, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
26,457. INSULATED COILS for ELECTRICAL APPARATUS, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
26,458. INSULATING ELECTRIC CONDUCTORS, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
26,459. BRAKE SYSTEMS, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
26,460. ELECTRIC RHEOSTATS, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
26,461. ROTARY ELECTRIC CONVERTORS, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
26,462. ELECTRIC ARC LAMPS, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
26,463. AIR BRAKE SYSTEMS, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
26,464. ELECTRICAL MACHINES, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
26,465. ELECTRIC MOTOR CONTROL, The British Thomson-Houston Company, Limited.—(*The General Electric Company, United States.*)
26,466. APPARATUS for BACTERIA BEDS, H. L. Doulton and R. J. Pleace, London.
26,467. VARIABLE SPEED FRICTION GEAR, F. Rawlings, London.
26,468. POWER HAMMER, H. B. Stocks and E. Allday, London.
26,469. ELASTIC TIRES for WHEELS, M. Vivian, London.
26,470. MOTOR CARS, The Albany Manufacturing Company, Limited, and F. Lamplough, London.
26,471. CENTRIFUGAL EXTRACTING APPARATUS, R. W. Schlenert, London.
26,472. AERATING BEER, E. C. Harvey, London.
26,473. AIR VESSELS, I. M. de Havilland, London.
26,474. HOSE COUPLING, A. F. Allan and J. A. Lenhoff, London.
26,475. PREVENTING COLLISIONS at SEA, E. Bernasconi, London.
26,476. ELECTRIC INCANDESCENT LAMPS, P. J. H. Driscoll and H. Sleemann, London.
26,477. STRING BOXES, R. W. Hudson and A. R. Pritchard, Liverpool.
26,478. ARTIFICIAL STONE, C. Reinke, London.
26,479. STEAM GENERATORS, W. S. Sargeant, London.
26,480. PYROCATECHOL DERIVATIVES, O. Imray.—(*Farbwerke vorm. Meister, Lucius, and Brüning, Germany.*)
26,481. SANITARY TOWELS, A. J. Boult.—(*Fulla Company Gesellschaft mit beschränkter Haftung, Germany.*)
26,482. TRICOLOUR HAND-SIGNAL LAMPS, V. I. Feeny, London.
26,483. WHEELS, J. Baker and Co. (Rotherham), Limited, and G. Baker, Sheffield.
26,484. PHOTOGRAPHIC APPARATUS, A. L. Adams, London.
26,485. PHOTOGRAPHIC CAMERAS, A. L. Adams, London.
26,486. FOCAL SHUTTERS, A. L. Adams, London.
26,487. BOTTLE WIRING MACHINES, C. V. Lennquist, London.
26,488. ELECTRICAL IGNITION APPARATUS, M. S. Napier, London.
26,489. VEHICLE WHEELS, J. A. and N. M. M. Legh, London.
26,490. SPINDLES of SPINNING FRAMES, C. Sella and G. U. Frova and Cie., London.
26,491. TOY WHISTLE, C. Nachtrieb, London.
26,492. EXTENSION BEDS, A. De Pinieo-Mallet, London.
26,493. PERSPECTIVE DRAWING INSTRUMENTS, H. C. Robinson, London.
26,494. BARBED WIRE, T. H. Monk, London.
26,495. STERILISATION of WATER, V. B. Nesfield, London.
26,496. ENGINE VALVE GEAR, H. S. Souttar and T. Hamilton-Adams, London.
26,497. MOWING and REAPING MACHINES, S. B. Bamford, London.
26,498. EXPLOSION MOTORS, J. Spyker, London.
26,499. STEERING GEAR for AUTOMOBILE VEHICLES, J. Spyker, London.
26,500. SPENCILS for EMBROIDERING MACHINES, M. Trautmann, London.
26,501. PANTOGRAPHS for MECHANICAL EMBROIDERING, M. Trautmann, London.
26,502. APPARATUS for THAWING WINDOWS, M. Trautmann, London.
26,503. MEANS for CONTROLLING TORPEDOES, A. Racic, London.

4th December, 1903.

26,504. MANUFACTURE of PADLOCKS, F. W. Pinson, Willenhall.
26,505. PHOTOGRAPHIC CAMERA ATTACHMENTS, T. Roche, Leicester.
26,506. EXPANDING SWEEP'S HOOD, M. E. Blackwood, Banbury.
26,507. MEANS of ATTACHING BEDSTEADS to FLOORS, T. Wilson, jun., and W. Marklew, Edgbaston, Birmingham.
26,508. TOBACCO PIPES, A. J. Pritchard, Manchester.
26,509. WINDOWS, W. Nicol, Glasgow.
26,510. CENTRIFUGAL PUMPS, R. T. Binnie, Glasgow.
26,511. ZINC-CUTTING LATHE, T. P. and J. Macnab, Manchester.
26,512. LETTER-BOX, P. Phillips, Torquay.
26,513. TROLLEY for ELECTRIC TRAMS, J. A. Macedo, Swillington, Yorks.
26,514. SCREW PROPELLERS, F. W. Lanchester, Birmingham.
26,515. SIDE SADDLES, T. U. Clarke, Birmingham.
26,516. ROLLER CUP CRANK for HARNESS SADDLES, W. J. Clare, Birmingham.
26,517. METAL RIMS of CYCLE WHEELS, E. C. Wasdell, Birmingham.
26,518. FIXING WRINGER BOARDS to WRINGING MACHINES, J. Taylor, Glasgow.
26,519. ELASTIC TIRE COVERS, P. A. and D. A. Martin, Birmingham.
26,520. CALCULATING or ADDING MACHINE, E. Samuel, Birmingham.
26,521. BLEACHING of TEXTILE FABRICS, J. Wakefield, Manchester.
26,522. POCKETS for BILLIARD TABLES, C. A. Richardson, Liverpool.
26,523. ATTACHING TIRES to WHEELS, J. Sloan, Belfast.
26,524. LIFE-SAVING DEVICE for VEHICLES, J. F. T. Jane, Southsea.
26,525. TIMBER WAGONS, A. J. Blackett, Stockton-on-Tees.
26,526. REMOVABLE INSPECTION WALL for FUEL ECONOMISERS, A. and R. B. Hilton, Portway Wells, Somerset.
26,527. TROUSER STRETCHER, G. N. Wilson, Aberdeen.
26,528. FIRE-GRATES for BOILER FURNACES, D. Roberts and C. James, London.
26,529. RENEWING STARTS in WATER WHEELS, E. J. Shearer, Turriff, N.B.
26,530. MECHANICALLY-PLAYING ORGANS, H. E. Fugill, Bristol.
26,531. POULTRY FEEDER, R. Gibson, Barrhead, Renfrewshire.
26,532. ADVERTISING DEVICE, H. S. Woodyer, Manchester.
26,533. ELECTRIC HEATERS, W. Krause, London.
26,534. CYCLE CLUTCHES, S. E. Eachus, J. C. Sharples, and A. V. Eachus, Preston.
26,535. KEY-OPENING STRIP CANS, C. L. Tweedale, Weston, near Otley, Yorks.
26,536. HOLDER for NOTE TABLETS, E. F. Haynes, Birmingham.
26,537. ELECTRIC CABLE CONDUIT, W. Hepworth-Collins, Manchester.
26,538. ELECTRIC CABLE CONDUIT, W. Hepworth-Collins, Manchester.
26,539. STEAM GENERATORS, W. Fairweather.—(*The Babcock and Wilcox Company, United States.*)
26,540. THREE-COLOUR PHOTOGRAPHY, W. N. L. Davidson, London.
26,541. PIANOFORTE PLAYERS, A. Maxfield, London.
26,542. WINDOW ATTACHMENT, W. S. Hill, London.
26,543. STERILISING WATER, A. T. Bean and E. White, London.
26,544. EMBOSSING MACHINES, D. M. Sutherland, Sunbury Common, Middlesex.
26,545. WINDOW CATCH and FASTENER, C. Wren, London.
26,546. MECHANICAL MOVEMENT, P. Bendixen and A. J. Jansen, London.
26,547. WATCHES, A. J. Bourlet, London.
26,548. DIFFERENTIAL-SCREWED JOINT, J. R. Badger, London.
26,549. TRAVELLING BAGS and their BUCKLES, F. A. Earle, London.
26,550. COAL-TRIMMING APPLIANCE, C. H. Windle, London.
26,551. METHOD of FORMING HIGH SHELLS of CARTOON on a DOUBLE-ACTING PRESS, C. Gossweiler, London.
26,552. CENTRIFUGALLY-ACTING GOVERNORS, L. W. Jones, London.
26,553. IGNITING MINERS' LAMPS, W., A., and R. O. Best, London.
26,554. PACKING, G. R. Beamer, London.
26,555. MANUFACTURING MOSAIC LINOLEUM, F. Walton, London.
26,556. PROCESS of PURIFYING LIGHTING GAS, J. Kerness, London.
26,557. COUPLINGS for RAILWAY CARRIAGES, J. Gouldie, London.
26,558. MANIPULATING VEHICLE BRAKES, J. Gouldie, London.
26,559. HOLDING or SUSPENDING TROUSERS, F. J. Marsh, London.
26,560. POWER STAMPING PRESSES, M. H. Sugden, London.
26,561. CLEANING CARDING ENGINE FLATS, W., T. W. H., and P. C. Philipson, London.
26,562. TOBACCO PIPES, S. Greenlees, London.
26,563. HACK SAW MACHINES for CUTTING METALLIC RODS, Hampton and Beebee, Limited, and J. Hampton, sen., London.
26,564. MACHINE for MAKING LOAVES, A. C. Macintosh and W. G. Thomas, London.
26,565. BOOT-CLEANING MACHINE, R. C. Fowler, F. T. Hill-Cottingham, W. A. Clark, and C. W. W. Whitham, London.
26,566. MOTOR CYCLES, C. Merington, London.
26,567. WEB STRETCHER, L. Holmwood and H. T. Page, London.
26,568. MANUFACTURING WORKS of ART, H. J. P. Dumas, London.
26,569. FACILITATING TRAWL FISHING, H. J. P. Dumas, London.
26,570. MANUFACTURING PLATED WIRE, A. Winter and Pforzheimer Doublefabrik Carl Winter, London.
26,571. SELF-ACTING WATER MOTOR, F. von Ehrenberg, London.
26,572. SIGHTS for GUNS of all CALIBRES, W. E. Corrigall, London.
26,573. VARIABLE SPEED GEAR for CYCLES, G. E. Seal and C. Ellis, London.
26,574. TOWING WINCHES, W. H. Harfield, London.
26,575. WEIGHING NITRO-GLYCERINE, G. E. Arnold, London.
26,576. RECORDING the PROFILE of BEDS of RIVERS, S. Hajós, London.
26,577. FIELD MAGNETS for ELECTRICAL MACHINES, G. Finzi, London.
26,578. CHUCKS of ROCK-DRILLING MACHINES, J. Hodge and J. Bartle, London.
26,579. CINEMATOGRAPH CAMERAS, The British Mutoscope and Biograph Company, Limited, and J. Mason, London.
26,580. LABELS, D. Anderson and R. G. King, London.
26,581. HEATING DEVICES for MOTOR CARS, H. S. H. Cavendish and H. Power, London.
26,582. PACKING FRAGILE ARTICLES, G. Denolly, London.
26,583. PIANO-PLAYING DEVICES, T. Coop, London.
26,584. MACHINES for BREAKING and CLEANING FLAX, G. S. Hunter, T. Burrows, and R. H. Kerr, London.
26,585. MOTOR-PROPELLED ROAD VEHICLES, J. E. Thornycroft, London.
26,586. PULL HANDLES, W. P. Thompson.—(*The Suberit Fabrik vormals Hagemann and Co., Germany.*)
26,587. BREECHES for SPORTING PURPOSES, M. Rothenbücher, Liverpool.
26,588. RAISING SUNKEN VESSELS, F. G. Nielsen, Liverpool.
26,589. INCANDESCENT ELECTRIC LAMPS, A. Bourdos and H. C. W. Gibson, London.
26,590. FLUID-PRESSURE TURBINES, Willans and Robinson, Limited, and J. Eaton-Shore, London.
26,591. WOVEN FABRICS, W. Watson and E. Hoyle, London.
26,592. EXPLOSION ENGINES, R. B. Ransford.—(*Société des Moteurs Thermiques à Grande Vitesse, France.*)
26,593. CLINICAL THERMOMETERS, F. Cessor, London.
26,594. DUST-COLLECTING DEVICE, T. W. Freeman and J. Perry, London.
26,595. ELECTRIC IGNITING APPARATUS, K. Schaffler and E. Jilck, London.
26,596. MANUFACTURE of PRODUCER GAS, E. Schweich, London.
26,597. CONVEYOR CHAINS, M. Garland, London.
26,598. REPAIR BANDS for TIRES, G. E. Osmond and S. Feast, London.
26,599. PNEUMATIC TIRES, G. E. Osmond, London.
26,600. CONSTRUCTION of ROOF ARCHES, P. Stephen, London.
26,601. WRENCHES for STAY BOLTS, P. Kolbe, London.
26,602. BUTTONHOLES, W. Coats, London.

5th December, 1903.

26,603. ELECTRIC MOTORS and DYNAMOS, H. Faerber, Bath.
26,604. WORKMEN'S IMPROVED DINNER BASKET, H. Brownson, Nottingham.
26,605. INVISIBLE BOOT PAD, G. C. Manzoni, Birkenhead.
26,606. CHART COMPASS CORRECTOR, S. Albrethson and G. A. Connell, Newcastle-on-Tyne.
26,607. COMBINED ELECTRIC SWITCH, H. Robertson, Edinburgh.
26,608. INFLATABLE TIRES, F. W. Barratt, Wimborne.
26,609. TARGET for use with AIR RIFLE, F. Dorsett, Manchester.
26,610. PORTABLE OVENS, W. Richardson, Stockton-on-Tees.
26,611. ROTARY PRINTING MACHINES, T. McKillop and H. W. M. Christie, Glasgow.
26,612. PETROL MOTORS, J. H. Clark, Glasgow.
26,613. CHIP BOXES, C. Maher and E. G. Moore, Liverpool.
26,614. SLIDE ATTACHMENT for BELTS, W. Spittle, Birmingham.
26,615. FIXING SIGNS on BARS, G., S., and W. Davis, Birmingham.
26,616. APPARATUS for GRINDING GRAIN, F. Todisco, Glasgow.
26,617. DRUGGET PINS, B. Fuller, Wolverhampton.
26,618. MECHANICAL SWITCH, R. C. Meredith, Bournville, near Birmingham.
26,619. LADY'S FRENCH SADDLE TREES, T. L. Woollatt, Walsall.
26,620. DECORATING POTTERY WARE, L. L. Grimwade, Manchester.
26,621. PLAYING CARDS, J. Taylor and C. E. Harrison, Manchester.
26,622. APPLIANCE for UNSTOPPERING BOTTLES, J. B. Henshaw and G. L. Munton, Sheffield.
26,623. SHEET DELIVERY MECHANISM for PRINTING PRESSES, W. C. Fairweather.—(*F. B. Redington, United States.*)
26,624. PADS of FELT HATS, R. Robinson and Turner, Atherton, and Co., Limited, Manchester.
26,625. BRAKE GEAR of RAILWAY WAGONS, L. D. Whitehead, Bristol.
26,626. ELEVATING GEAR, F. Wigley and H. H. Mulliner, Birmingham.
26,627. WEIR PASSES for Use by SALMON, J. G. Williams, Birmingham.
26,628. STONE-SAWING MACHINERY, A. G. Grice and G. Anderson and Co., Limited, Dundee.
26,629. APPLICATION of TUBE BEADERS, C. Wicksteed, Kettering.
26,630. WATERPROOFED FISHING LINES, M. Carswell, London.
26,631. WHEEL TIRES, A. Scott, London.
26,632. COMPOUND BATCHING OIL, J. N. Nicholson and J. A. Shepherd, London.
26,633. FLOAT-FEED CARBURETTERS, W. J. Iden, Coventry.

26,634. CONTACT BREAKERS, &c., J. L. J. Gobiet, Coventry.
26,635. VARIABLE SPEED DRIVING GEAR, E. Stubbs, Coventry.
26,636. GRINDING MACHINERY, T. Wright, Coventry.
26,637. FENDERS and FENDER CURBS, W. Ogilvy, Birmingham.
26,638. INCANDESCENT GAS BURNERS, W. Beal, Birmingham.
26,639. NICOTINE CARTRIDGE for TOBACCO PIPES, A. Pflueger, Berlin.
26,640. POCKET UTENSIL for SMOKERS, A. Pflueger, Berlin.
26,641. CHIMNEY-HEADS, C. Eneweldsen, Berlin.
26,642. EMPTYING CONDENSERS, J. Wildemann, Berlin
26,643. MEASURING INSTRUMENTS, R. Pesch, Berlin
26,644. KEY-CHANGING DEVICE, J. Ramsperger, Berlin.
26,645. PHOTOGRAPHIC CAMERAS, H. Major, London.
26,646. MANUFACTURING CONFECTIONERY, H. T. Averay Jones, London.
26,647. CALCULATING APPARATUS, C. Lamey and A. Hauff, jun., Berlin.
26,648. PORTRAYING NOTES of MUSIC, T. H. Fosbrooke, London.
26,649. ELASTIC WHEELS, E. Saddington, London.
26,650. BOILER FURNACES, E. F. Comber, London.
26,651. PAPER for STEREOTYPE MATRICES, C. Sureties, London.
26,652. SPEED INDICATORS, A. E. Moore and A. Darch, London.
26,653. OIL COOKERS, H. Cole and A. E. Palmer, Birmingham.
26,654. GAS and OIL EXPLOSIVE ENGINES, F. Lyst, London.
26,655. MAKING ARTIFICIAL STONE, C. H. Robottom, London.
26,656. FIRE BLOCK for HEATING PURPOSES, C. Davies, Liverpool.
26,657. MEANS for CLOSING LEAKS in SHIPS, L. Krüger, Liverpool.
26,658. FIRE-HOSE APPARATUS, H. Williamson, Liverpool.
26,659. MAGNETO-ELECTRIC IGNITION DEVICES, P. Masson, London.
26,660. CARTRIDGE and FIRING CAPS, P. Brighenti, London.
26,661. MACHINES for STONING CHERRIES, H. Creste, London.
26,662. DENTAL APPLIANCES, R. Brumslow, London.
26,663. APPARATUS for PRESSING TROUSERS, L. Robertson, London.
26,664. PREVENTING WASTE of LIQUIDS, G. Cruickshank, London.
26,665. OBTAINING SYRUP from BEETS, W. C. Salisbury and A. J. Kramper, London.
26,666. DISCRUSTANT for STEAM GENERATORS, H. H. Lake.—(*A. Jacob, Belgium.*)
26,667. ROTARY EXPLOSION ENGINES, R. C. N. Palairet, London.
26,668. PRODUCING METAL SULPHIDES, O. Meurer, London.
26,669. MANUFACTURE of SLABS of COMPRESSED CEMENT, O. V. Rysselberghe, London.
26,670. HAIR NETS, D. M. and R. P. Maxwell, London.
26,671. HAY LOADERS, J. and D. Maxwell, London.
26,672. CRADLES, P. Fineman and D. Goldberg, London.
26,673. EXPLOSION MOTORS, F. Brückert, London.
26,674. APPARATUS for COOKING FRUIT, R. Kuczmera, London.
26,675. MACHINE for WINDING YARNS, C. Müllers, London.
26,676. RECREATION RAILWAYS, E. Land and W. Evans, London.
26,677. LOCOMOTIVE FIRE-BOXES, W. R. Preston and W. S. Rogers, London.
26,678. INDICATING SPEED of REVOLVING SHAFTS, L. W. Sterne, London.
26,679. MEANS for PUNCHING HOLES in BELTS, W. M. Hawnt, London.

7th December, 1903.

26,680. TWINE-POLISHING MACHINES, W. G. Bywater, Leeds.
26,681. HAND BAGS, M. Plümacher and M. Kass, Barmen, Germany.
26,682. LOCKING RAILWAY CARRIAGE DOORS, A. B. D. Lang, Weybridge.
26,683. MEANS for SUSPENDING CLOTHES LINES, M. O'Brien, Burnley.
26,684. MANUFACTURE of BATTEN SCREW RODS, C. Showell, Birmingham.
26,685. RUNNERS for CURTAIN RODS, W. Allman, Birmingham.
26,686. CAMERAS, E. W. Houghton and E. D. Smith, London.
26,687. ELECTRIC LAMPS for MOTOR CARS, R. Lee, London.
26,688. ILLUMINATING the NUMBER PLATE on MOTOR CYCLES, E. Bigg, Brighton.
26,689. PLUG COCKS for BLAST FURNACE PLANT, R. S. Pollard, Stockton-on-Tees.
26,690. CIRCULAR KNITTING MACHINES, J. C. Wilson and A. Pape, Nottingham.
26,691. ELEVATORS and CONVEYORS, D. L. Hutchison, London.
26,692. SOCKS for BOOTS and SHOES, E. W. Gough Halifax.
26,693. DOORS, A. E. Alden, South Norwood.
26,694. SEWING NEEDLES, J. Howarth, Manchester.
26,695. CARBURETTERS, F. W. Hayward and R. C. Fox Norwich.
26,696. APPARATUS for WASHING CLOTHES, T. Dickinson, Accrington.
26,697. CIGARETTE HOLDERS, R. Kerr, Glasgow.
26,698. BELT FASTENERS, I. Jackson, Manchester.
26,699. MEANS for COMPRESSING AIR, J. Howarth, Manchester.
26,700. DYESTUFFS, E. E. Nacf and I. Levinstein, Manchester.
26,701. WASHING MACHINE, D. L. Martyn, East Boldon, R.S.O.
26,702. SLIDING SASH WINDOW, S. Blight, Croydon.
26,703. HARDENING STEEL CUTTERS, S. N. Brayshaw, Manchester.
26,704. CONSTRUCTION of CRATES, C. W. Ralph, Stoke-on-Trent.
26,705. LITHOGRAPHIC MACHINES, W. Sinclair and W. A. Ireland, Glasgow.
26,706. MACHINE TOOL HOLDERS, E. F. Robertson and P. W. Fawcett, Sheffield.
26,707. REDUCING the SKIN FRICTION of VESSELS, G. Chapman, Glasgow.
26,708. TRAILERS for ATTACHMENT to BICYCLES, C. E. Green, Leeds.
26,709. TORCH LAMPS, T. F. and J. H. Braime, Leeds
26,710. SUSPENDED CLOTHES-RAILS, E. C. Hudson, London.
26,711. SAUCERS, J. W. Cooper, Manchester.
26,712. CONTINUOUS MUFFLE FURNACES, L. L. Grimwade, Manchester.
26,713. AUTOMATON for ADVERTISING PURPOSES, F. P. Barthel, Germany.
26,714. BED TABLE, A. E. Aldworth and T. A. Gooch, London.
26,715. CLOSING and OPENING DOORS, G. Sheard, Liverpool.
26,716. FAN DRIVEN by CLOCKWORK, L. O. Jürgens and A. W. R. Edwards, Derby.
26,717. PNEUMATIC VEHICLE TIRE, H. R. Weaver, London.
26,718. REVOLVING ILLUMINATED SHADE CARD, J. Hindley, Manchester.
26,719. AUTOMATIC SWITCH for OVERHEAD RAILWAYS, J. Matt, Tipton, Staffs.
26,720. STARTING DEVICE for INTERNAL COMBUSTION ENGINES, J. H. Bishop, London.
26,721. SPEED RECORDERS for TRAMCARS, H. Hartley and V. Canova, London.
26,722. POWER-TRANSMITTING DEVICE, W. Simkins, London.
26,723. COMBINED MILK-STRAINING and SAMPLING APPLIANCE, C. C. Lance, London.
26,724. PAPER-FEEDING MACHINES, T. C. Dexter, London.
26,725. PAPER-FEEDING MACHINES, T. C. Dexter, London.
26,726. SPRING FRONT FORKS for BICYCLES, R. W. Dickinson and F. Stevenson, Accrington.
26,727. OIL LOCOMOTIVE ENGINES, H. P. Saunderson, London.
26,728. OIL and SPIRIT MOTORS, H. P. Saunderson, London.
26,729. CHANGE SPEED MECHANISM, W. J. Iden, Coventry.
26,730. CURTAIN CLIP, C. T. Gann and F. R. Keep, London.
26,731. PLATFORM, J. W. Rice, London.
26,732. TELESCOPES, A. E. Conrady and F. W. W. Baker, London.
26,733. CELLULOID COMPOUNDS, J. E. T. Woods and C. Morgan, London.
26,734. MATCH BOXES and CASES, H. L. Symonds, London.
26,735. MUDGUARDS of BOOTS and SHOES, J. W. Potter, London.
26,736. OVERSPEED GEAR of ENGINES, W. B. Hall, Leeds.
26,737. HINGES, J. Harper and Co., Limited, and A Doman, Willenhall.
26,738. SOAP DEVICE for SHAVING, F. H. Loring, London.
26,739. AUTOMATIC FEEDING of MACHINES, E. Watzke, London.
26,740. AUTOMATIC SPEED INDICATOR, H. L. Barraclough, London.
26,741. INCANDESCENT BURNERS for GAS, J. Cox, London.
26,742. CONTROLLING WINDOW BLINDS, A. and G. Tye, London.
26,743. CLEANING WINDOWS, H. Buttrum, Stony Stratford, Bucks.
26,744. EMBROIDERED SHAWLS, P. Kriesel and Gebr. Chevalier, London.
26,745. SPANNERS and WRENCHES, A. E. Crawford, Croydon.
26,746. HANDLE for PETROL MOTOR CYCLES, H. L. Cocks, London.
26,747. HANDLE for MOTOR CYCLE VALVES, H. L. Cocks, London.
26,748. MOUNTING for ROTARY SCRAPERS, A. E. Watson, London.
26,749. APPARATUS for RETTING and PREPARING FIBROUS STEMS, G. S. Hunter, T. Burrows, and R. H. Kerr, London.
26,750. LIGHTING NUMBER PLATES of VEHICLES, J. A. Davenport, Liverpool.
26,751. KILNS, W. Morris, Birmingham.
26,752. JOINTS for TRAMWAY RAILS, J. Trippett, Sheffield.
26,753. NAILS, G. Anderton, London.
26,754. GAUGES, W. F. Stanley and W. F. Stanley and Co., Limited, London.
26,755. INLAID VEGETABLE IVORY BUTTONS, C. Franzo, London.
26,756. SAWS, H. Baumert, London.
26,757. TABLES, R. Niemann, London.
26,758. CUSHION for LESSENING SHOCK, J. P. Edmunds, London.
26,759. WHEELS for ROAD VEHICLES, G. J. Arnold, London.
26,760. HOOK for SUSPENDING ARTICLES, F. Lehmann, London.
26,761. PACKING, The Hydroleum Motor Company, Limited, and J. Badger, London.
26,762. ENGINES, The Hydroleum Motor Company, Limited, and J. Badger, London.
26,763. SIGNS, M. Auzéric, London.
26,764. TIRES for VEHICLES, G. J. Monson, London.
26,765. PREPARATION of MEAT, R. S. Hutton, London.
26,766. AUTOMATIC COUNTING MACHINES, A. J. Boult.—(*A. R. Jennings, Germany.*)
26,767. MANUFACTURE of IRON and STEEL, W. Owen, London.
26,768. LABELLING MACHINES, S. E. Young and T. H. Baker, London.
26,769. IRONING APPARATUS, A. J. Boult.—(*V. Biguinot, France.*)
26,770. MACHINES for MAKING ENVELOPES, A. J. Boult —(*M. R. Dünnebier, Germany*)
26,771. FIRE and DRAUGHT SCREEN, H. F. Patten, London.
26,772. ARC LAMP for HIGH TENSIONS, T. L. Carbone, London.
26,773. ARC LAMP, T. L. Carbone, London.
26,774. FIRE-GUARDS, W. Milroy, Liverpool.
26,775. MANUFACTURE of TANTALUM, C. D. Abel.—(*Siemens and Halske Actien Gesellschaft, Germany.*)
26,776. MANUFACTURE of INCANDESCENT BODIES, C. D. Abel —(*Siemens and Halske Actien Gesellschaft, Germany*)
26,777. TREATMENT of LEAD SULPHIDE, P. A. Guye, London.
26,778. KILNS, B. Blount and R. E. Middleton, London.
26,779. ANNULAR MOULDS for TREATING SUGAR, J. C. F. Lafeuille, London.
26,780. SHIPS' PROPELLERS, H. L. Harris and P. St. G. Kirke, London.
26,781. HORSESHOE CALKS, J. Abbs, London.
26,782 BOILERS, J. McWilliams, London.
26,783. RAILWAY SWITCHES, C. W. Breedlove and R. R. Grant, London.
26,784. BRAKES for RAILWAY WAGONS, J. Lancaster, London.
26,785. AROMATIC ETHERS, G. B. Ellis.—(*Chemische Fabrik von Heyden Aktiengesellschaft, Germany*)
26,786. BOTTLES, W. B. Smith, London.
26,787. CAMERAS, A. S. Newman and Newman and Guardia, Limited, London.
26,788. ELECTRO-MOTORS of the INDUCTION TYPE, L. M Lewis London.
26,789. FOUNTAIN PENS, J. Balog, London.
26,790. VALVE GEAR for STEAM ENGINES, A. Bollinckx, London.
26,791. DRESSING EMERY WHEELS, H. J. Haddan.—(*The Desmond-Stephan Manufacturing Company, United States.*)
26,792. ELECTRIC SANITARY CLOSETS, J. H. Wilson, London.
26,793. EXTINGUISHING VAPOUR LAMPS, H. J. Haddan.—(*The Aktiengesellschaft, formerly C. H. Stobwasser and Co., Germany.*)
26,794. OPERATING RAILWAY VEHICLE BRAKES, L. Selle, London.
26,795. RADIATORS and CONDENSERS, F. E. Bennett, London.
26,796 PORTABLE CASES for BUTTER, H. H. Pickard, London.

8th December, 1903.

26,797. UNSPILLABLE INK CONTAINER, G. B. Moultrie, Hadleigh, Essex.
26,798. COMPOSITION for REPAIRING BOOTS, H. S. Snell, Merton, Surrey.
26,799. PRESS for PRESSING TROUSERS, W. Wall, Bradford.
26,800. FASTENERS for BOOTS and SHOES, F. Whatton, Birmingham.
26,801. MEANS for CARRYING MOTOR LAMPS, F. A. Powell, Birmingham.
26,802. QUICK-WEIGHING BALANCE, J. J. Hutchinson, Dublin.
26,803. HYGIENIC ENVELOPE, D. F. Guiffey and J. D. Ware, Weston-super-Mare.
26,804. POST MORTEM GLOVE, F. W. Mitchell, Seven Kings, Essex.
26,805. RUBBER BATH GLOVE, F. W. Mitchell, Seven Kings, Essex.
26,806. BICYCLE LANTERNS, C. F. and P. H. England, Bristol.
26,807. SPARKING PLUGS, C. Marston and P. L. Renouf, Wolverhampton.
26,808. TELEGRAPH POLES, W. L. Bullows, Walsall.
26,809. FIRE HOSE CARRIER, F. Venus, J. Wright, and A. Harvie, Uckfield, Sussex.
26,810. ROAD RAILWAY POINTS, W. H. Travers, Liverpool.
26,811. CIGAR HOLDERS, B. T. Howard, Birmingham.
26,812. MAKING ACETYLENE GAS, J. W. Waddington and M. Broadbent, Hull.
26,813. PENDULUM GRADE METER, W. Sayer, Derby.
26,814. CHILDREN'S GARMENTS, Peel, Watson and Co., Limited, and A. Reynolds, London.
26,815. RAILWAY for POPULAR RECREATION, R. R. Thom, Troon, N.B.
26,816. CARBURETTERS, H. du Cros, jun., and C. T. B. Sangster, Birmingham.
26,817. WAIST BELTS, P. A. Martin, Birmingham.
26,818. WATERING CANS, T. Norbury, Manchester.
26,819. POWER LOOMS, D. Nelson, Glasgow.
26,820. MULE SPINNING FRAMES, J. Haigh, Bradford.
26,821. AERIAL MACHINES, B. F. S. Baden-Powell, London.
26,822. APPARATUS for SUPERHEATING STEAM, A. Bolton, Manchester.
26,823. GAS-LIGHTING APPLIANCE, J. T. Pearson, Burnley.
26,824. EXHAUST BOXES, C. Rainey, Bexley Heath, Kent.
26,825. ELECTRIC INDICATING DEVICE, G. E. Watmough, Leeds.
26,826. CULTIVATORS, W. Poole, Glasgow.
26,827. WIND MOTORS, D. Burns and J. M. Fleming, Glasgow.
26,828. TAP for LIQUIDS, A. M. S. Watts, Glasgow.
26,829. DOMESTIC FIREPLACES, W. Jones, Garth, Bangor.
26,830. OPENING TEXTILE PIECE GOODS, W. Mycock, Manchester.
26,831. HORNS for TALKING MACHINES, H. Sheble, Manchester.
26,832. SLIDE LATHES, I. Bost, Manchester.
26,833. PRINTING WALL PAPERS, E. and T. Entwistle, Manchester.
26,834. CORSETS, H. C. and J. J. N. Snow, London.
26,835. PAY-BOXES for WAGES, T. F. and J. H. Braime, Leeds.
26,836. CLOTHES LINES, W. G. Ward, Whitwell, Derbyshire.
26,837. PAVING BLOCKS, T. Leadbeater and H. D. Blake, Leeds.
26,838. INTERNAL COMBUSTION ENGINES, J. H. Hamilton, Sandiacre, near Nottingham.
26,839. STOPPING a HORSE from FREEING ITSELF from a CART, J. H. Gilbert, Buxton.
26,840. ELECTRIC BOOT POLISH, C. Collins, Ramsgate.
26,841. EGG TOPPER and SAVING SPOON, W. J. Matthews, Cirencester.
26,842. ELECTRIC SWITCHES, Crompton and Co., Limited, and A. J. Hodgson, Chelmsford.
26,843. ARC LAMP SUSPENSION APPARATUS, Crompton and Co., Limited, and A. J. Hodgson, Chelmsford.
26,844. NUT WRENCHES, D. Stewart, London.
26,845. CURING TEA LEAF, S. E. Haskin and H. Howden, London.
26,846. LOCOMOTIVE BOILERS, A. G. Brookes.—(*J. M. McClellon, United States.*)
26,847. TAPPING APPARATUS, F. Pentlarge and J. H. Vehr, London.
26,848. TELEPHONE SYSTEMS, W. Fairweather.—(*The Stromberg Carlson Telephone Manufacturing Company, United States.*)
26,849. TELEPHONE SYSTEMS, W. Fairweather.—(*The Stromberg Carlson Telephone Manufacturing Company, United States.*)
26,850. SELECTIVE SIGNALLING SYSTEMS, W. Fairweather.—(*The Stromberg Carlson Telephone Manufacturing Company, United States.*)
26,851. CENTRAL EXCHANGE APPARATUS, W. Fairweather.—(*The Stromberg Carlson Telephone Manufacturing Company, United States.*)
26,852. REVOLVING MAPS, J. Sayar and F. W. Schroeder, London.
26,853. HOISTING APPLIANCE, J. T. Pickering, London.
26,854 PILLOW CASE, T. Somerset, D. C. Hutchinson, and H. E. Turkington, London.
26,855. HAMMER CHECK ACTION for PIANOFORTES, R. Streich, London.
26,856. ELECTRIC CIRCUIT BREAKER MECHANISM, Crompton and Co., Limited, and R. C. Harris, London.
26,857. ELECTRIC ARC LAMPS, Crompton and Co., Limited, and A. J. Hodgson, London.
26,858. ADJUSTABLE CARRIER for LAMPS, T. Ledward, London.
26,859. PROPELLERS, S. Dalziel, London.

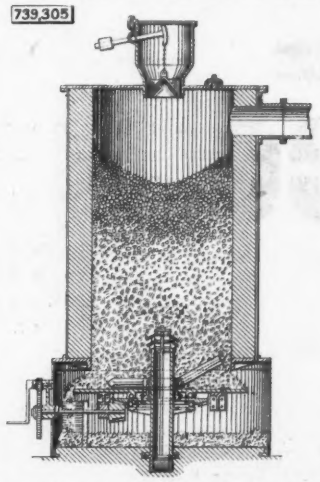
SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

739,305. GAS PRODUCER, *A. M. Gow, Edgewood, Pa.—Filed February 5th*, 1902.

Claim.—(1) The combination of a gas-making chamber, a fixed table of larger diameter located below the gas-making chamber, and supporting the fuel body, a fixed twyer for the admission of air and steam located centrally in the gas-making chamber, an ash poker having its opposite sides of similar curvature concentric with the twyer, and capable of being moved in either direction in a plane parallel to the face of the fixed table. (2) The combination of a gas-making chamber, a fixed table of larger diameter located below

739,305

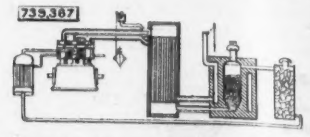


the gas-making chamber and supporting the fuel body, a fixed twyer for the admission of air and steam, located centrally in the gas-making chamber, a hub surrounding the twyer and connected by suitable gearing with a source of power outside the gas-making apparatus so as to be capable of being moved in either direction, and an ash poker connected with the hub, and having its opposite sides of similar curvature, the ash poker lying in a plane parallel to the face of the fixed table.

739,367. GAS-PRODUCING SYSTEM, *G. Westinghouse, Pittsburg, Pa.—Filed April 10th*, 1900.

Claim.—(1) The combination with a gas engine, of a gas producer, means for passing a portion of the exhaust gases from the gas engine into and through a jacket surrounding the producer, and means for forcing a portion of such exhaust gases into and through the producer. (2) A producer for converting hot products of combustion, air and coal into combustible gas, consisting of a producer-chamber, an inlet for the hot

739,367

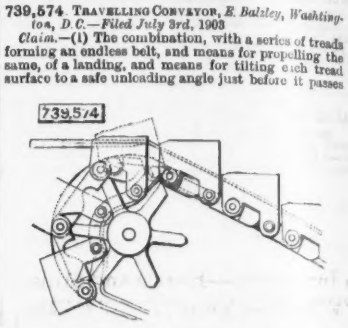


products of combustion, a jacket surrounding the producer chamber, and air passages therethrough for passing heated air into the producer.

739,574. TRAVELLING CONVEYOR, *E. Balsley, Washington, D.C.—Filed July 3rd*, 1903

Claim.—(1) The combination, with a series of treads forming an endless belt, and means for propelling the same, of a landing, and means for tilting each tread surface to a safe unloading angle just before it passes

739,574

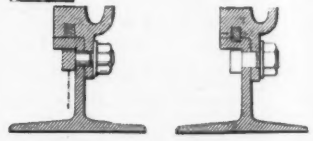


beneath said landing. (2) A step for a travelling conveyor, comprising spaced segments each composed of box-like side pieces secured together and provided with ribs, and a tread piece held between said side pieces at their upper ends and supported by said ribs.

739,819. ELECTRICAL TRAMWAY OR RAILWAY RAIL, *H. M. and H. M. Bigwood, Wolverhampton, England.—Filed April 14th*, 1903.

Claim.—A tramway rail comprising a base, web and tread portion, said tread portion formed of a plurality of sections, each of said sections having on its lower face a groove, the groove of one section registering

739,819

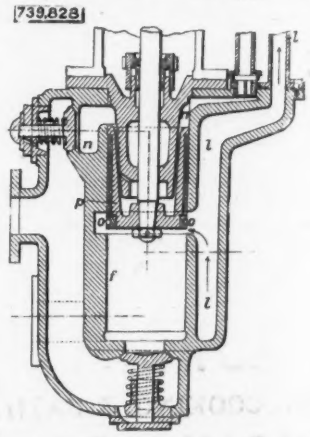


with the groove of the other section, a bond mounted in said grooves and engaging the web for bridging the joint between the said sections, and means for securing said base and tread portions together, said tread and web portions when set up enclosing said bond.

739,823. DOUBLE-ACTION FEED PUMP FOR STEAM GENERATORS OR OTHER APPLICATIONS, *C. Caille, Le Perreux, France.—Filed May 1st*, 1903.

Claim.—An apparatus for forcing liquids, consisting of a pump cylinder *f*, a cylinder *a* forming an extension of said cylinder *f* an opening *o* between said cylinders, a chamber *l* communicating with said opening, said chamber being connected to a source of supply, a piston *p* formed with a chamber in its upper

739,823

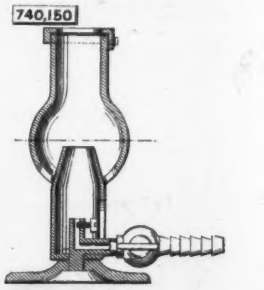


part, a chamber *n* above said piston connecting with the chamber in said piston, and a discharge pipe connected to the chambers formed in the cylinders *a* and *f* whereby on the downward stroke of the piston the water in the chamber in the cylinder *f* will be discharged, and on the upward stroke the water in the chamber *n* will be discharged, the water flowing into one chamber while the water in the other chamber is being discharged.

740,150. BUNSEN GAS HEATING BURNER, *J. J. Lawler, Mount Vernon, N.Y.—Filed April 21st*, 1902.

Claim.—In a device of the type set forth, a primary mixing chamber merging into a contracted neck and having an air inlet, an enlarged secondary mixing

740,150



chamber surrounding said first-named chamber and having air inlets located beneath said contracted neck, and a nozzle having a set screw extending into the inlet thereof and in horizontal alignment with the air inlet of the primary mixing chamber, substantially as described.

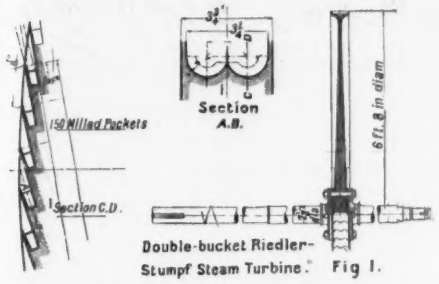
NEW FORMS OF THE STEAM TURBINE.

By ROBERT H. SMITH.

No. II.*

AT this point we must, in passing, express a slight difference from Professor Riedler's opinion. High speed wheels and discs stand in danger, not only from radial accelerations and the stresses due thereto, but also from tangential or angular accelerations. These latter do not arise so long as there is absolutely steady working, that is, so long as perfect equality is maintained between driving and driven moments. In a steam turbine the driving moment is maintained very steady indeed—probably steadier than in any other kind of driving machine, steadier even than in an ordinary electro-motor. But there is no greater guarantee in turbines than in other motors for even approximate steadiness in the moment of resistance in the machinery that is driven. Now, the stressing effects of variation of moment of driven resistance, leading to tangential or angular plus and minus accelerations in the wheel, become more serious the higher the speed. It is notorious that fly-wheel breakdowns are more commonly due to these stresses than to the radial stresses.

On account of the steadiness of the radial stressing,



Double-bucket Riedler-Stumpf Steam Turbine. Fig 1.

Dr. Riedler and Professor Stumpf think that from 2 to 2½ as factor of safety is admissible; and state that, therefore, the above-named speed of 3000 revolutions per minute in a 7ft. wheel of cast steel of 50 kilos. per square millimetre breaking strength—or 33 tons per square inch—should be considered safe. In the first wheels made by them they used nickel steel of 75 kilos. per square millimetre—or 50 tons per square inch—elastic limit, and this gave them a factor of safety 4. Experiments were made to test whether "self-strains" arose in the wide flange of the wheel in this material when either cold or warmed by the steam. The flange was slit in many places round the circumference, and the wheel run full speed under steam. The slits showed no signs of opening out or other deformation, and this was accepted as proof that these strains did not exist.

With an error of mass-centering not more than $\frac{1}{2500}$in., rise above the "critical" speed is not risky. In the actual machines the passing of the critical speed cannot be detected except by specially expert observers. The long bearings in which the shaft is mounted give to the minute extent that is necessary to establish the automatic balance to reach which the Laval shaft is made flexible. At from 3000 to 4000 revolutions per minute the running is said to be so quiet that ordinary observation will not reveal whether the wheel is running or standing.

Fig. 1 shows the elements of construction of a wheel with divided or double bucket, the impinging steam jet being parted by the midrib between the two shallow pockets milled in the rim. In this wheel, which is 6ft. 8in. in diameter, with 3¾in. width of rim, the milling tools used are 1½in. in diameter, and just over ¼in. thick at the circumference. The pitch between the buckets measured on the outside periphery of the wheel is about 1⅛in., the total number of pairs being 150.

Sometimes only one pocket is milled in the flange breadth, and sometimes the two side by side are of unequal diameter. In Fig. 2 they are seen in the plan to be unequal. Here the working steam jet *j* impinges on the inner edge of the smaller pockets, sweeps round the semicircle of these pockets outwards, and finds exit from the wheel at *e*, with a backward velocity of about seven-tenths the original impinging velocity. This backward issuing jet is caught up at *c* by the fixed box or tube guide *c r*, which leads it round a semicircle without doing work, and, therefore, without loss of velocity except from

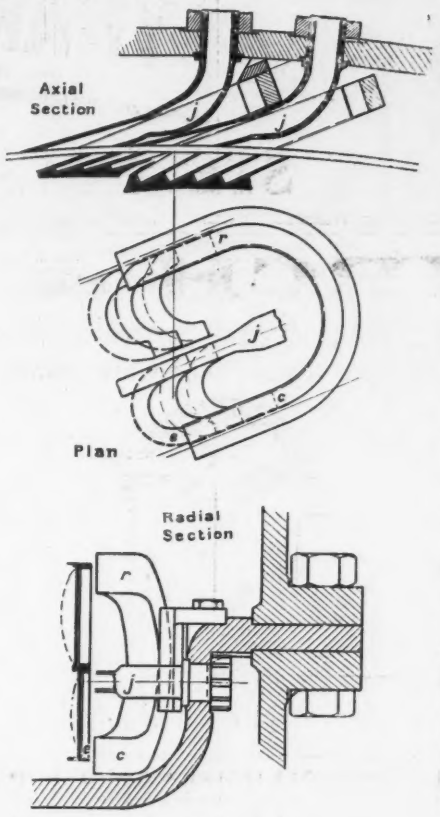


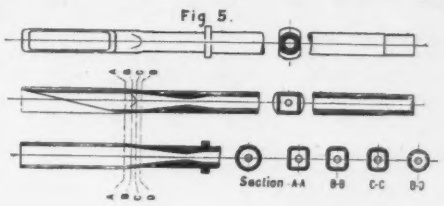
Fig. 2

friction. This guide converts the direction of the jet to approximate parallelism once more with the wheel motion; and from *r*, the open discharge end of the guide, it once more impinges upon the wheel, driving it forwards by sweeping round the semicircle of the larger of the two sets of buckets. It issues from these with most of its kinetic energy spent, the second half of it spent in driving the larger buckets.

Here the whole drop of pressure takes place before discharge from the nozzles *j*; there is no staging of the pressure fall. But the kinetic energy is spent in two stages corresponding with two separate falls in the velocity. This is the staging of the utilisation of kinetic energy referred to in No. 2 of the four fundamental problems which Professors Stumpf and Riedler proposed to solve. It is to be noted that if there be no fall of pressure throughout these two stages, there will be also no change of density, except from cooling by contact with colder walls of metal passages. As the steam is, however, already very cool—it may be down to 150 deg. to 180 deg. Fah.—there ought not to be much loss in this way. There being no change of density, there is no occasion for change of cross section of passages, except in the ratio of enlargement corresponding with the decrease of velocity.

So far only two-stage utilisation of the kinetic energy seems to have been attempted. There is no sound reason why three and four stages should be impossible; but between each stage there is considerable loss by lateral spraying or dispersion of the jet. It is to avoid such loss that rigid close guidance of the stream of steam is throughout necessary. This is impossible unless the various fixed and running guide passages are small in cross section. It is only by partition of the total acting stream into comparatively small streamlets, each separately guided, that wasteful eddies, cross-currents, and spraying can be avoided. Thus, the second stage reversing guides *c r* are composite channels. This is seen in the drawings, Figs. 3 and 4. Fig. 3 shows the reversing guides used with a single wheel whose flange has one set of buckets only, occupying the whole width of the flange. The jet, after passing from *j* round the semicircular path of the running bucket, is caught up at *c*, led round the fixed guides *c r*, and impinges, by discharge from *r*, *once more on the same set of buckets*, the discharge openings *r* standing right ahead of *j*. Fig. 4 shows the same arrangement applied to a wheel with two rows of buckets milled side by side in its flange. In both these, Figs. 3 and 4, it is evident that the main nozzles *j j* must be spaced at considerable peripheral distances apart, because the discharges *r* of the reversing

Fig 5.



guides come between successive nozzles *j*. In the arrangement of Fig. 2 the nozzles *j j* may be placed close together, and the impinging steam then forms a compact, undivided ring-stream. This is said to give the better effect; and when it is not desired to impinge over the complete circumference of the wheel, it is found better to block the jets close together in two, three, or four groups. Figs. 3 and 4 show distinctly the cellular structure of the reversing guides.

Fig. 5 shows the form of jet nozzle used. These are formed out of cylindric tubes whose interiors are bored to the desired variation of section. The forward portion is then pressed into square or rectangular sectional form, and, finally, the discharge ends cut off slant to the correct angle. The jets always act on the outside cylindrical surface of the wheel flange, never on its flat face. The angle at which the milled pockets need to be cut in considerably reduces the *effective* diameter of the wheel; but it is said that this disadvantage is more than compensated for by the small viscous and eddy resistance to the running at high speed through steam. The correct forming of the nozzles was proved by experiments to be a fundamental necessity. They are made of a nickel steel, with such nickel percentage as prevents rusting from the steam contact. Rust on the internal walls of the nozzles lowers greatly the efficiency of the whole turbine.†

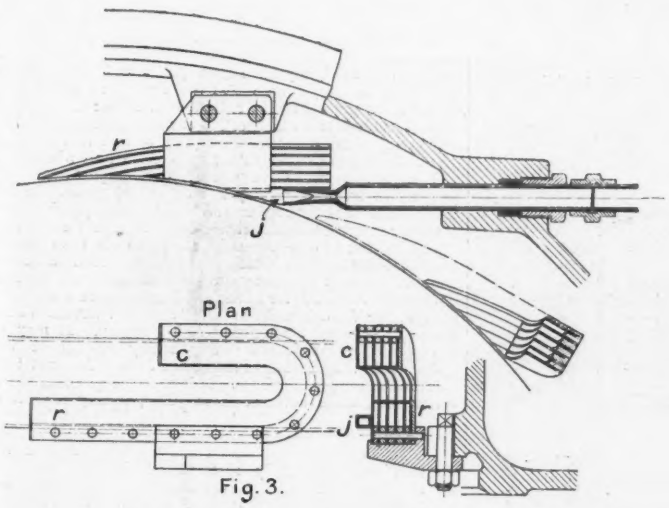


Fig. 3.

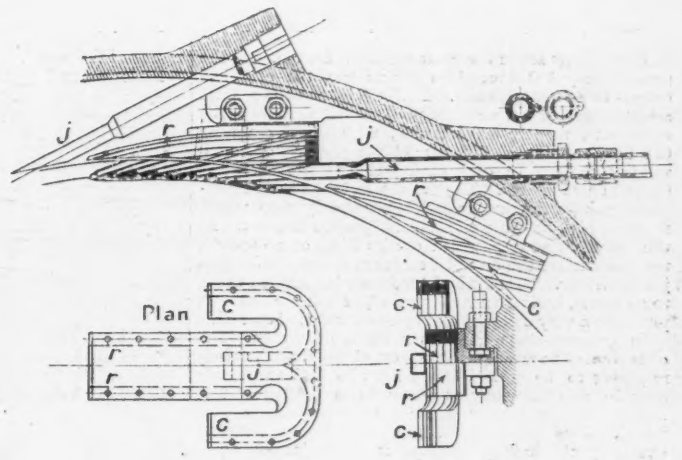


Fig. 4.

Turbines on these lines, with the whole pressure fall occurring before discharge upon the wheel, have been made by the A.E.G. Company of Berlin up to 5000 kilowatts, with 4 m. diameter, at 1500 revolutions per minute. A 2000 horse-power runs at 3000 revolutions per minute with 2 m. diameter.

In Fig. 6 we illustrate in cross and longitudinal sections a small 20 horse-power turbine and continuous-current dynamo, running at 3500 revolutions per minute without condenser; the turbine diameter is only 32in. It will be seen that the turbine is direct coupled on the overhang of the dynamo shaft, and that it occupies a great deal less bulk than the dynamo itself.

When the pressure fall is broken into stages, the successive turbine wheels are placed in entirely separated chambers. In two-stage pressure fall, the two chambers

* No. I. appeared December 18th.

† The point referred, mentioned in the last paragraph of article No. I., is as to the radial or centrifugal stresses, which are advantageously steady and "quiet," being the most dangerous stresses.

with their two wheels may be placed just beyond the two main bearings of the dynamo or other machine to be driven, the two turbines on the shaft overhanging these bearings, and an intermediate receiver pipe passing from

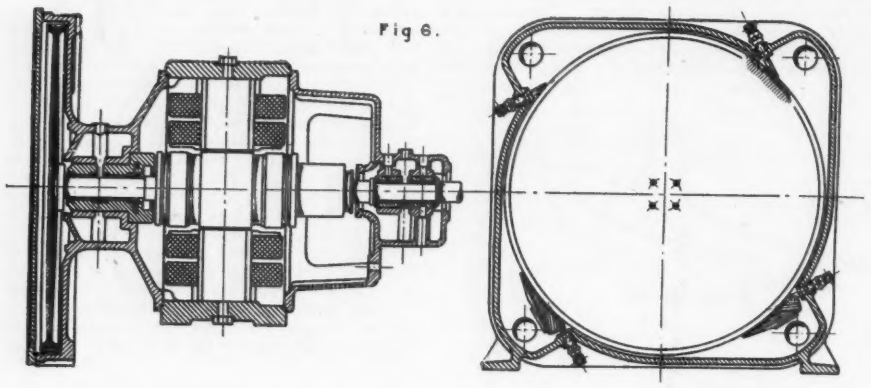


Fig 6.

end to end under the bed plate or to one side of it. Fig. 7 shows a similar arrangement of four turbine wheels, each with two-stage utilisation of kinetic energy, in four

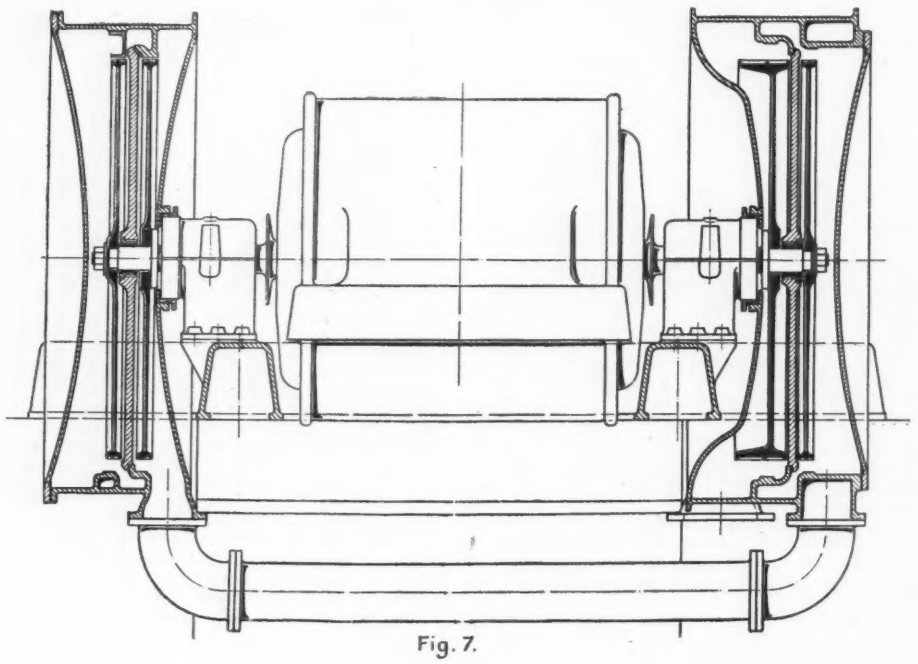


Fig. 7.

separate steam chambers or cylinders. Here all the turbine wheels are of the same diameter, 6ft. 8in., and the speed is only 500 revolutions per minute, the electrical output being 500 kilowatts. In Fig. 8 is seen the general arrangement of a four-stage pressure fall turbine of the same size, namely 500 kilowatt, with wheel diameter 6ft. 8in., running at 750 revolutions per minute, on a vertical shaft. In each casing the kinetic energy is spent in two stages. The weight is taken on a collar-bearing above the turbine and below the dynamo, which floats on high-pressure oil retained by a stuffing-box. At the bottom foot-step, which carries little or no weight, the shaft drives the disc of a centrifugal pump injection-jet condenser. This kind of condenser is attached easily to all forms, horizontal and vertical, of the turbine. It produces a very compact and symmetrical *tout ensemble*.

In pressure-stage turbines with condensation it is endeavoured to arrange the one or, at most, two bearings requiring to be packed steam-tight so that the inside may be approximately at atmospheric pressure. The aim is always to develop about equal horse-power in each wheel. This means equal kinetic energy and therefore equal impact velocity. For equal impact velocities, equal peripheral bucket velocities are needed; so that this leads to the same diameter of wheel being correct for all the stages, all of them being mounted on the same shaft.

It should also be noted that in consequence of the inlet and outlet apertures being on the cylindrical surface of the wheel, there is little or no axial or end pressure to be taken at bearings or otherwise. In fact, this form of steam turbine, in common with the double-bucket Pelton wheel, is radically different from any of the three divisions of the orthodox turbine classification into parallel or axial flow and inward and outward radial flow. It is axial flow, inasmuch as the curvature of the stream giving the driving effect is in planes parallel to the axis; but orthodox axial-flow turbines have their inlet and outlet apertures in the flat transverse surfaces. On the other hand, radial-flow turbines have their inlet and outlet openings, one in the outside cylindrical and the other generally, although not necessarily, in a flat transverse surface, while the stream curvature producing the driving effort is necessarily in a plane perpendicular to the axis of rotation. The Pelton-Riedler-Stumpf construction has an efficiency which does not seem to be so sensitive to exact correct adjustmust between peripheral speed to impact jet velocity. And, especially in the Riedler-Stumpf form, it allows of complete deflection of the stream through the full 180 deg., which cannot be obtained with any other existing construction. The whole of this deflection is effective in driving effort, although the radius giving moment to this driving effort is not the full radius of the wheel.

Prolonged and apparently trustworthy tests of the steam

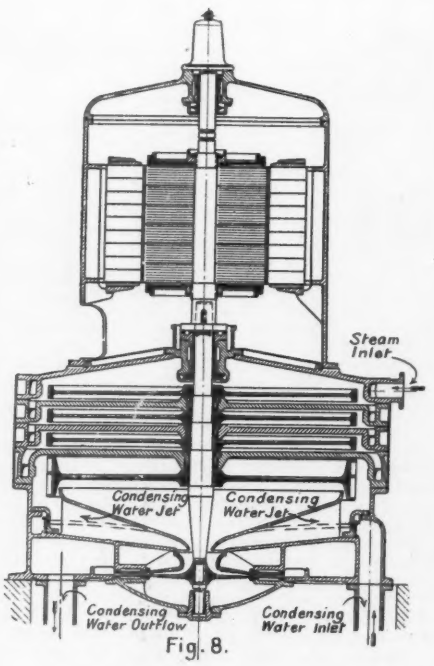


Fig. 8.

consumption of these turbines have been made in the Imperial Technical High School of Berlin and in the Moabit works of the A.E.G. The makers have aimed at a number of grades between the two ideals of small size at low prime cost, where steam economy is not of first importance, and the other of mean and large size, where low steam consumption and steady running are essential.

With small 32in. wheels running at 3500 revolutions per minute, without condensation, without pressure stages, and with a single utilisation of the impact velocity, the steam consumption was 57 lb. per brake horse-power at 20 horse-power.

With same size, speed, and horse-power, also without condensation, but with two-stage utilisation of kinetic energy in one single pressure fall, the consumption was 37½ lb. per brake horse-power hour.

The first trial 500 horse-power wheel of only 5ft. diameter, which was unsuitably small and was used because of want of confidence regarding the centrifugal stresses, gave 28½ lb. per brake horse-power hour without condensation and without staging either pressure or velocity.

A 2000-horse-power turbine, still without any staging, but furnished with condenser and centrifugal air-pump, direct coupled to a continuous-current dynamo, at 3000 revolutions per minute, and at half power, consumed from 15½ lb. to 16 lb. per horse-power hour of electric output. At full power at same speed, with 9 atmospheres steam pressure and 294 deg. Cent. steam temperature, and 648 mm. mercury of condenser vacuum, the steam consumption was 14½ lb. per horse-power hour of electric output. This would correspond to 13 lb. if the vacuum had been 0·95 atmosphere, and it would be still lower—Dr. Riedler calculates 12½ lb.—if the full correct velocity were given to the wheel.

Measured consumptions of the wheels with pressure and velocity stages do not appear to have been published as yet.

NEW VAUXHALL BRIDGE.

No. III.*

The portion of the work comprised in "Contract No. 1," in connection with the building of new Vauxhall Bridge, has now been successfully accomplished. It included the piling, concreting, and the getting in of the whole of the foundations, and the erection of the stone infrastructure up to the level of +9·75ft. above Ordnance Datum. In Fig. 1, p. 612, is represented a general elevation of the whole bridge, which is symmetrical upon each side of a vertical axis passing through the crown of the central arch. There is a slight difference in the treatment of the abutments and short, straight back wingwalls at the ends. On the Lambeth shore they are both built solid, although an arch is turned and afterwards blinded, in the abutment. On the Westminster side the abutment is pierced by an arch over a footway 8ft. in width. Another is built under the wingwall to take a roadway 18ft. wide. This arrangement is to be altered. The bridge consists of five spans of a segmental form, of the dimensions given in Fig. 1, arranged so that, counting from the Westminster end, Nos. 1 and 2, though of different lengths themselves, correspond with Nos. 4 and 5 upon the other side of the centre arch, which has a maximum span of 149ft. 7in. Similarly to the spans, the rises, or heights above T.H.W., have different values. They are, for the centre span, 20·75ft.; for the intermediate, 19ft.; and for the shore spans, 14·92ft. On the north side of the river the approach is upon a gradient of 1 in 37·29, and upon the south of 1 in 40·75. At the level of + 9·75 the intermediate piers have a thickness of 14ft. 8in., and the central piers of 1ft. more. For a distance extending from the crown of each intermediate arch across the central span, the radius of the surface of the centre of the roadway is 7559ft. longitudinally.

The steel design belongs, constructively, to the arched rib type, articulated at the springings and continuous at the crown, or what is known as a two-hinged arch. In the earlier examples of both cast and wrought iron arches, all hinges or pivots, both at the crown and the springings, were scarcely ever used, any more than they were in the old stone and brick bridges, from which the former no doubt took pattern. At present the introduction of two or three hinges in most modern stone bridges is a common occurrence. The application of hinges at the springings of cast and wrought iron arches dates back to rather more than half a century, and a few remarks respecting the employment and progress of the system may not be out of place. In the original design of the cast iron arch bridge of Stephenson, proposed for crossing the Menai Straits, the arch was given a cylindrical form at the springings. The ends thus shaped fitted into the bearings, which were hollowed out in a similar manner. Hinges of a very similar character were used by the late Sir John Fowler in the two handsome cast iron arch bridges, the Victoria and the Albert, on the Severn Valley Railway, between Shrewsbury and Bewdley. It may be a disputed point whether any rotary motion of the cylindrically shaped ends of the arches does or does not take place in the supporting shoes. It is mainly a question of the amount of friction between them. But, in any case, it is essential that a perfectly true fit should exist between the surfaces of the upper and lower parts of the bearings. Otherwise it would not be certain that the pressure was accurately situated within the limits of the area assigned to it. A decided check to the progress and further development of iron arches, as well as to those of stone, was given by the introduction of the horizontal principle, which endured for some time. At the present date the longest span of the horizontal or girder system, with parallel booms, is the Ohio Bridge, of 515ft., and the same dimensions for polygonal girders is 353ft., also in America. At Luxembourg the record for a stone arch type is of 275ft., and the steel arch, crossing the Niagara at Clifton, of 853ft., is the widest span of any arch in the world. It appears that the first application of hinges at the springings to wrought iron arches was made in 1858, in the construction of a railway bridge over the St. Denis Canal, on the Paris and Creil line.

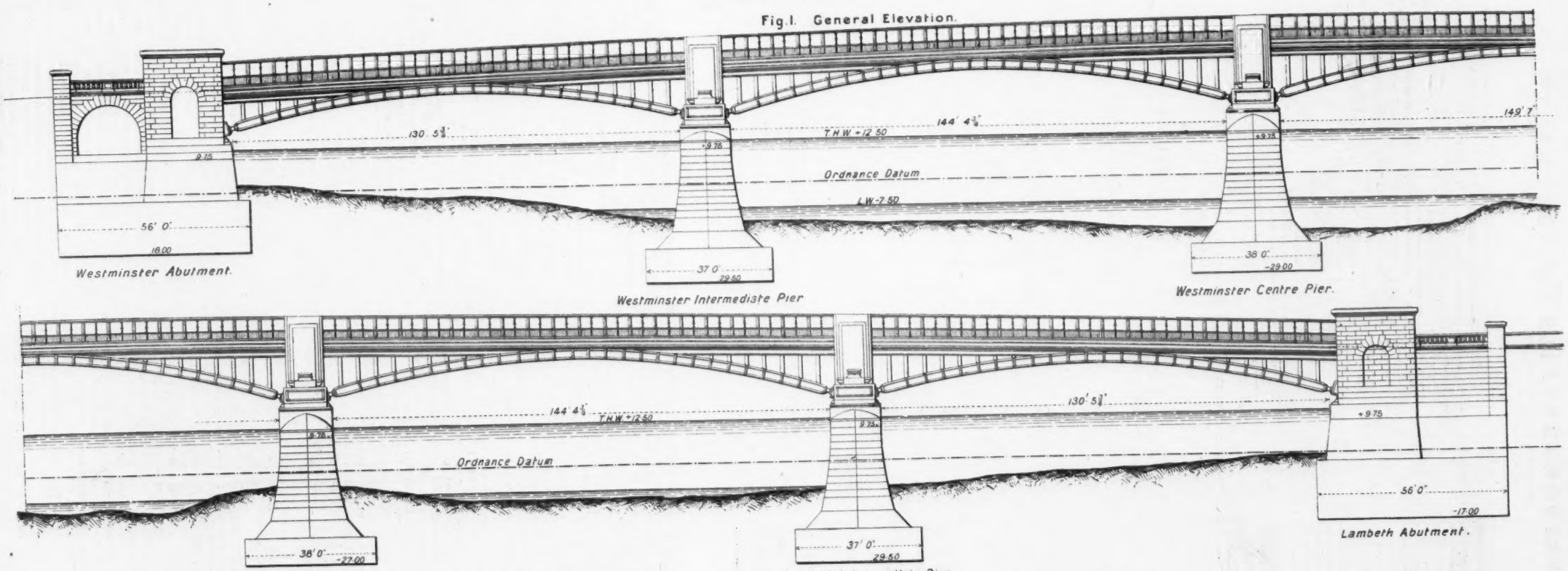
At the crown the steel ribs—Fig. 1—have a depth of 3ft. 6in., increasing to 4ft., near the bearings at the point where the section is bent to receive the pivot attachment. Consequently the extradosal and intradosal curves are not quite concentric, both having different radii, varying with the different spans. The spandrils are of the vertical type, the struts being spaced at equal distances apart, corresponding to the positions of the radial stiffening steels upon the face of

* No. II. appeared on September 4th.

PLAN AND ELEVATION OF NEW VAUXHALL BRIDGE

(*For description see page* 612)

Fig. 1. General Elevation.



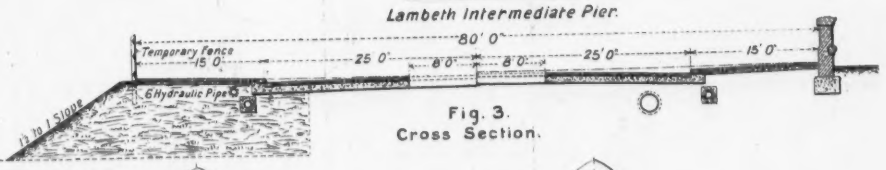


Fig. 3.
Cross Section.

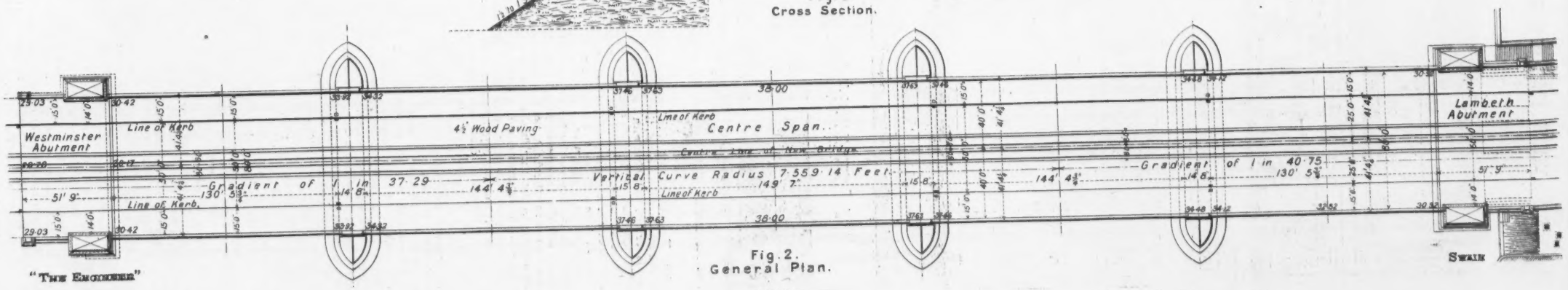
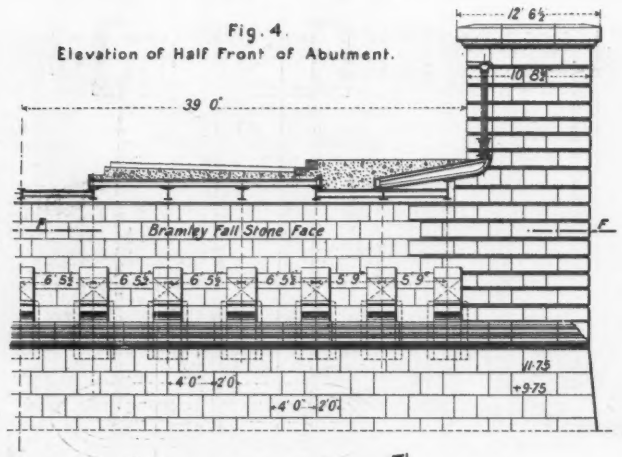
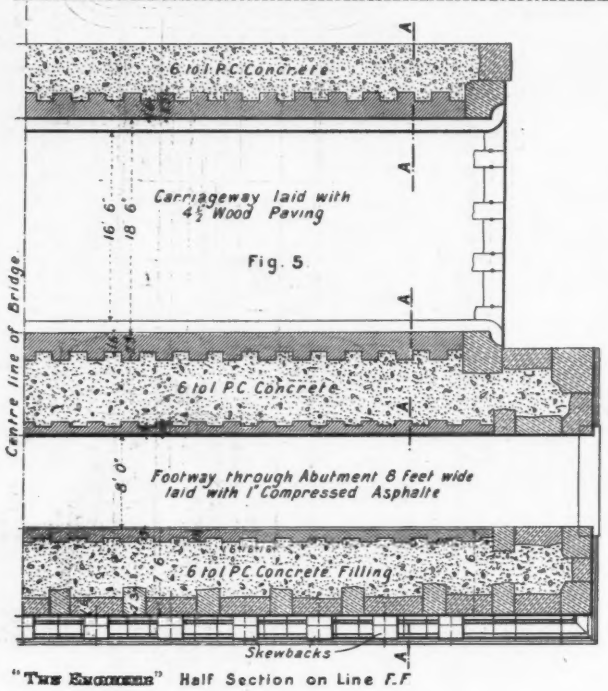


Fig. 2.
General Plan.

NEW VAUXHALL BRIDGE—DETAILS OF ABUTMENTS

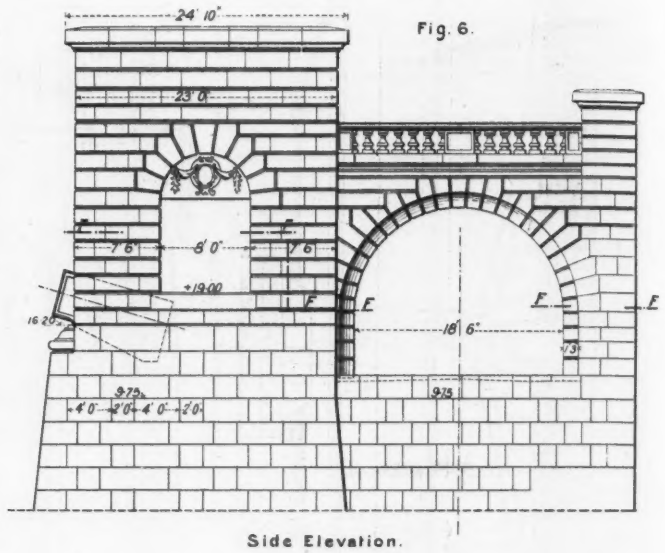
Fig. 4.
Elevation of Half Front of Abutment.





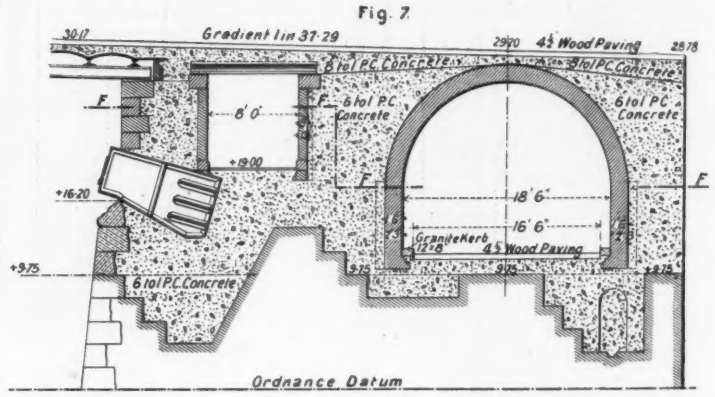
"THE ENGINEER" Half Section on Line F.F

Fig. 6.



Side Elevation.

Fig. 7.



Longitudinal Section on Line A.A.

SWAIN

the main ribs. From the surface of the footway to the top of the cast iron coping of the parapet, the total height is 8ft., of which the lower half is filled in with a series of bars, 1in. square, of wrought iron. The upper open space is broken by a succession of alternate standards and ornamental balusters, which carry the coping, and are continued downwards to the ends of the steel cantilevers supporting the footpaths, which project 3ft. beyond the face of the arches. In the elevation—Fig. 1—the projecting part of the steel skewbacks is shown, and also the general design of the hinges. Over the piers it will be noticed that the cast iron panels are without any device. A few other details also depend upon the character of these ornaments. The junctions of the parapet with the piers, the spacing of the cantilevers under the footpaths, and the adjustment of the expansion joints will be shown in detail in another article. A general plan of the bridge, exclusive of the approaches, appears in Fig. 2. Over all, to the outer edge of the parapet copings, the extreme width is 82ft. 8½in., and inside parapets the clear width is 80ft., divided into a roadway, 50ft., and two footpaths, each 15ft. in width. A space of 8ft. on each side of the centre line of the bridge is provided for the double tracks of the tramway which will run over it. Underneath the north-western footpath, looking down stream, in the direction of the axis of the bridge, are laid a 14in. gas main, a 6in. hydraulic main, and a 9in. stoneware drain pipe. An 18in. gas main, and a stone drain pipe, also of 9in. diameter, are carried below the surface of the opposite footway. The broken lines showing these mains and pipes in the original drawing are not reproduced, to avoid confusion in the general plan, Fig. 2. These and other particulars will be given to a larger scale when the details of the structure are explained. Outside the kerbstone, which is of granite 12in. by 8in., is laid a channel 12in. by 7in., and gullies and inspection pits are provided at regular intervals. It will be seen from Figs. 1 and 2 that the centre part of the bridge is a great deal flatter than the side portions. The gradients of 1 in 37·29 from the Westminster, and of 1 in 40·75 from the Lambeth approach, extend to the centre of each intermediate span respectively. Between these latter points, which are upon each side of the centre span, the surface of the road is a vertical curve, struck as already mentioned, with a radius of 7539·14ft. It thus happens that the central span is the only one of the five which has both the springings of its arch at the same level. The Westminster approach is straight on the east and curved on the west, and terminates at a junction with Grosvenor-road. That on the Lambeth end starts upon a curve 25ft. from the face of the abutment, and finishes opposite Upper Kennington-lane, where it joins the South Lambeth-road. A considerable quantity of property, some of an expensive description, had to be acquired to make the Surrey-side approach upon the north-east shore.

In Fig. 3, p. 612, is a cross section taken through the approach at the back of the Lambeth abutment, looking towards the Vauxhall Station of the London and South-Western Railway. On the right of the figure is the permanent parapet, bedded upon a block of concrete, 3ft. by 2ft., and standing 5ft. 6in. above the footway, with granite stringcourse and coping, each 12in. in thickness. For the whole width, with the exception of the 8ft. upon each side of the centre line, reserved for a tramway, the roadway of 4½in. wood paving is laid upon a concrete course 9in. thick, and the stoneware drain pipes are set in the same material. A layer of sand, 3in. in thickness, carries the 3in. York paving forming the footpaths. That on the left of the section rests upon an embankment made of any approved hard, dry, clean filling material. It may be mentioned that a small part of one side of the Vauxhall approach cannot be quite completed until it has been arranged what is to be done with the old buildings and land which the County Council acquired for the new structure. All the concrete used in the cross section is mixed in the proportion of 8 to 1 of Portland cement to the other ingredients. The laying of the tramway tracks is not included in the present contract, nor have the lighting arrangements been definitely decided upon.

An elevation of half the front of the Westminster abutment is given in Fig. 4 above. All the facework above the springings consists of Bramley Fall stone, in regularly-coursed ashlar masonry, 1ft. 6in. in height. Below the moulded stringcourse, immediately underneath the steel skew backs, the stone courses are 2ft. in height. In Fig. 5 is a horizontal half section, on the line F F in Fig. 4. It will be seen that the carriageway, 18ft. 6in. in width, passes between two side walls built of brickwork, with a minimum thickness of 1ft. 6in., increased at regular intervals of 1ft. 6in. by projections or small counterforts 12in. by 9in. At the back of the walls are masses of concrete 4ft. thick, well rammed into the spaces, to make a good bond with the brickwork, which consists of the best picked stocks, faced with glazed bricks. A granite kerb, 12in. by 8in., on each side of the roadway, acts as a fender to protect the glazed surface of the walls. The walls of the small footway arch are built of the same material, and after the same patterns, but are of a smaller section, being only 9in. in thickness, with counterforts of an extra brick. A full side elevation of the two archways, and the whole of the Westminster abutment from front to rear is represented in Fig. 6, and the general effect is both pleasing and appropriate, without presenting the heavy, massive, and ponderous appearance which characterises the abutments and porticoes of many of the large German bridges. Both the roadway and footway arches are semicircular, and the continuation of the arch stones of the wider example, to the ground level, give it all the properties of a stilted arch. A batter of 1 in 10, as shown in Figs. 4-7, is the slope of the walls of the abutment below the string course. The depth of the keystones of both arches is 2ft. 9in., and the coping of the open balustered parapet is 4ft. 8in. above the level of the footpath.

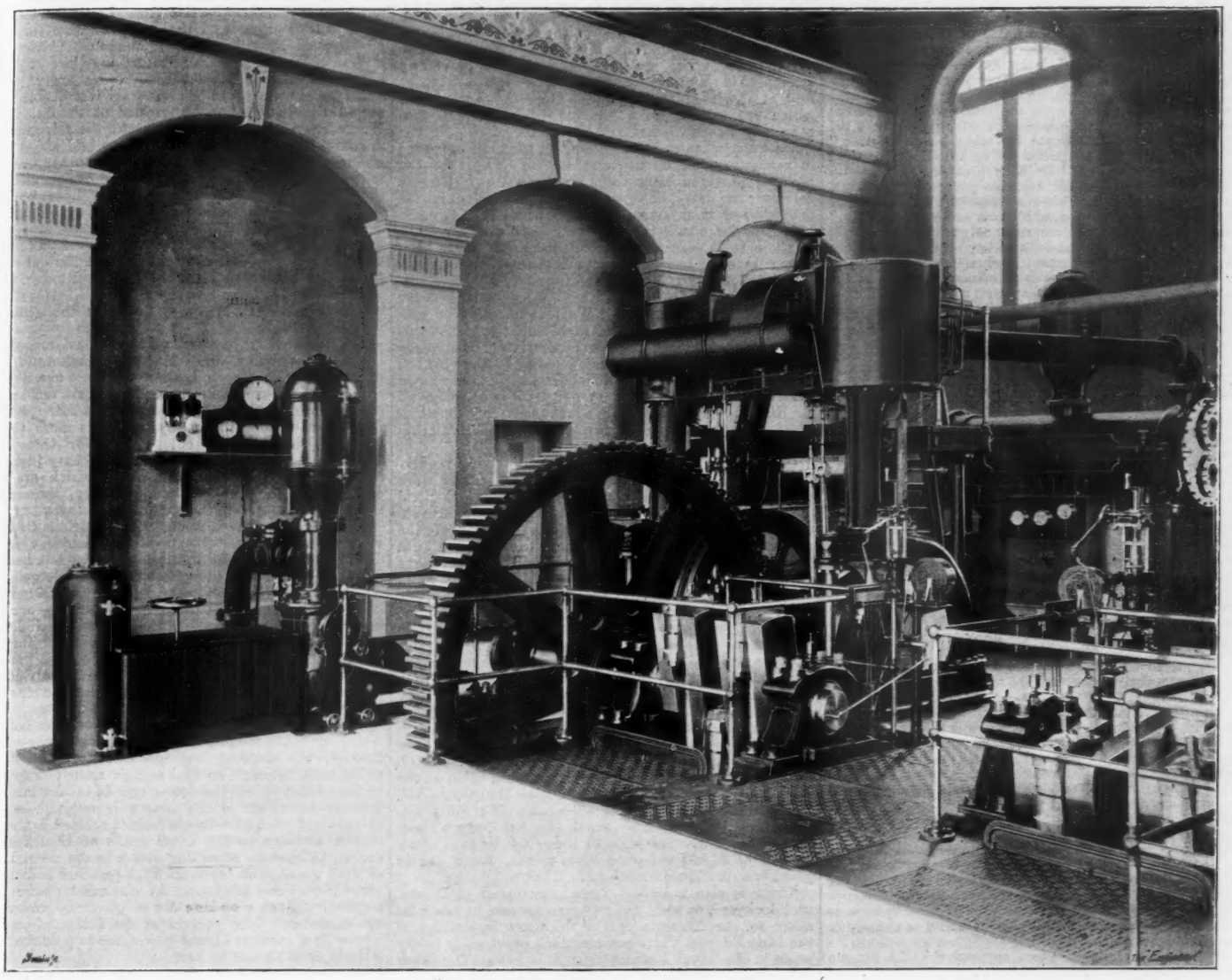
Fig. 7 is a longitudinal section on line A A, in Fig. 5, showing the construction of the two arches through the abutment inside the stone facework. The larger arch is turned in a thickness of four brick rings, and is to be faced with glazed bricks similarly to the sides, and the rest of the dimensions are the same as those described when treating of Fig. 5. Over the crown of the arch, sloping down to the haunches, the concrete is in the proportion of 8 to 1. Through the abutment, the opening for the footway takes the form of a rectangular passage, 8ft. by 8ft , which corresponds with the opening in the side elevation of the abutment—Fig. 6—as the arch proper is filled in with ornamental stonework and tracery. To the left of the figure a small portion of the steel joists and plates carrying the roadway, and forming the platform or flooring of the bridge, is shown. The steel skewback is 10ft. along the upper sloping surface, has an abutting bed of 5ft. 6in. against the mass of concrete constituting the backing of the abutment, and a face 4ft. in depth, in a plane perpendicular to the line of thrust of the arch. In Fig. 7 the upper gradient line, with the corresponding numbers, represents the levels of the centre of the roadway, at the points where they occur. The irregularly hatched lining under the lower part of the concrete indicates the finished part of the Westminster abutment under the first contract. It should be stated once for all, that the drawings and description are in accordance with the conditions prescribed for the steelwork and superstructure in "Contract No. 2." The London County Council reserves to itself, as is usual in all similar works, the right to make such alterations as it may consider desirable.

NEW WATER SUPPLY FOR MARGATE.

THE question of a better water supply to Margate has pressed heavily on the Corporation for many years past. The original pumping works are situated at the Tivoli, and to meet the requirements of the growing population the Dane Works were constructed in 1886. These works have been the means of averting the complete breakdown of the water supply for some years, but the carrying out of the main drainage scheme in 1888-90, and the consequent great impetus to building operations, caused a much greater demand for water, which the combined works were totally unable to meet, the result being that the water supply was not only greatly insufficient in quantity, but inferior in quality, the water-line being reduced to such an extent that the wells during the summer season were nearly always pumped down below sea level, and frequently pumped out. In 1895 Mr. Mansergh was called in to advise the Corporation, and the following year he made a report recommending that a new supply should be taken

MARGATE WATER SUPPLY—PUMP ROOM AT WINGHAM

MR. ALBERT LATHAM, M. INST. C.E., ENGINEER



from the surface-water stream running from Wingham. For several reasons this scheme fell through, and in 1898-99 the Corporation put down an experimental deep bore-hole in the Dane penetrating the lower greensand, at a cost of £1476, but the water was found to be too brackish for domestic use, and therefore the work had to be abandoned. In the year 1900 the Corporation promoted a Bill in Parliament to procure water from Brooke's End, Mr. Baldwin Latham being the engineer. This Bill failed to obtain parliamentary sanction. In 1901 the Corporation put down a supplementary salt-water scheme at a cost of £3225, and the same year experimented further in trying to obtain water from Nash Court at a cost of £975, which experiment also failed to supply any appreciable amount of water. The scheme which was finally adopted received parliamentary sanction last year, and was completed this year, was propounded by Mr. Albert Latham, the borough engineer.

The site of the works is on the mainland at Uffington, in the parish of Wingham, near the outcrop of the line of chalk hills ranging from Canterbury to Dover. The scheme includes the sinking of the pumping well and adits driven in the chalk to a depth of 3000 yards at the level of Ordnance Datum, which is 132ft. below the surface at the pumping station, the site of which is at least a mile from the nearest house in the village of Wingham. On this site, which is six acres in extent, have been erected engine and boiler-houses, workshops, storehouses, coalshed, weighbridge, a block of commodious cottages for the staff, engineer's house, board-room, workmen's bath, stable, coach-houses, &c.

It was estimated that two million gallons of water per diem could be obtained from these works, as the water-line stood at 33ft. above Ordnance Datum, rising to 156ft. above Ordnance Datum at Womenswold, about four miles to the south, there being an area of 15 square miles to draw upon. It has been found that this estimate was very much too low, it being now evident that there is sufficient water to be obtained here to supply the whole of the Isle of Thanet. One-third only of the length of adits has been driven, which length yields over 2½ million gallons per diem, or more than double the present requirements of the town. This quantity can be increased to 5 or 6 million gallons if required in the future. To construct this length of adits—namely, 1000 yards—it has been necessary to pump about 500 million gallons of water to waste, which is more than the total quantity of water supplied from both pumping stations in Margate for the last two years. To show the recovering power of the wells on the cessation of the pumping, the water-line rose in a few days to within 4ft. of its original level. The water is delivered into the town by means of an 18in. cast iron main, 14 miles in length, through which the water is pumped from the well by two duplicate triple-expansion engines and pumps of 166 horse-power each. Each pump at its normal speed will deliver two million gallons of water in the twenty-four hours, or one million gallons in the twelve hours, but they are both capable of working at a much greater speed. These pumps were supplied by Messrs. J. Simpson and Company, Limited, of Pimlico. The 18in. main was designed to pass one million gallons of water in the twelve hours, but such care has been taken in the laying, and such easy curves have been introduced that we understand that the estimated friction has been reduced, so that the main will really deliver a much greater quantity of water per diem. We are informed that each section of the main was subjected while under construction to a high water pressure. The works were commenced at the end of October last, and were pushed on so expeditiously, both day and night, as to enable the water to be delivered in Margate nine months from the date of starting, the supply being officially turned on by the Mayor of Margate on August 6th last.

PUMPING STATION AT WINGHAM

The parliamentary estimate, including the rising main, buildings, engine and pumps, well and adits, with 10 per cent. added for contingencies, amounted to £83,985, whereas the contracts entered into by the Council for carrying out the work amounted to £70,750. In connection with this scheme the

Corporation of Margate have extended their water district so as to include about seventeen parishes in East Kent, covering an area of about 50 square miles, therefore becoming the dominant water owners in East Kent. Two supplementary pumps have been erected at the works, and also a reservoir completed at Uffington, and a high-level tank at Woodlands, three miles distant on the high ground, the top water-line of which is 332ft. above Ordnance Datum and the level of the floor of the adits at Uffington. One of the contracts for the mains comprises over fourteen miles of main. Before the scheme was finally adopted by the Corporation they took the opinion of two engineers—Messrs. Hawkesley and Eaton—and Mr. Whittaker, the geologist, who reported "they considered the scheme would afford a good and ample supply of water, admirable in quality and sufficient in quantity to meet the growing demands of Margate for many years to come." Samples of water were submitted to two specialists for their examination and opinion. Dr. Klein pronounced the water to be "of good quality for domestic purposes;" and Mr. Sidney Harvey, analytical chemist, reported the water to be "a true chalk water without admixture, and of great purity," that a gallon of this water contained only 2·65 grains of salt, as compared with the excessive quantity—159 grains—in the old supply, and its permanent hardness was only 2·2, or less than one-eighteenth of the permanent hardness of the Tivoli water, in which a recent analysis gave 41·3 grains per gallon permanent hardness. Our illustrations show inside and outside views of the pumping station at Wingham.

ELECTRIC TRAMWAYS IN SOUTH LONDON.

AN attempt to introduce the overhead trolley system in the south of the metropolis is proposed to be made by the London County Council, provided that arrangements can be made with the local authorities for this purpose. It had been thought by members of the Council that the first steps in connection with the establishment of the overhead trolley method would be taken in the north on certain of the lines leased to the North Metropolitan Tramways Company, but as the reconstruction of a length of twenty-two miles of this particular network on the conduit plan has been definitely settled upon, the question of installing the overhead system on the other leased lines may be said to remain in abeyance at the present time. Pending any further action in the north, it may be mentioned that in the south the tramways owned by the London Southern Tramways Company will next year fall under the purchase clause of the Tramways Act, 1870, and if they are to be acquired by the London County Council on that occasion, notice must be served upon the company not later than the third week in February, 1904. These lines, which extend from Vauxhall to Camberwell-green and to Norwood respectively, are about 5¾ miles long, and are partly single-track with passing places. The idea has occurred that it might be possible to lay down the conduit system from Vauxhall along South Lambeth-road to the junction with Clapham-road, and then continue the line on the overhead trolley method along Stockwell-road to Camberwell-green on the one hand, and Norwood on the other. It would be necessary for this purpose to reconstruct the tramways of double track throughout and widen the roads, the total cost being estimated at £375,000. Of this total, the sum of £254,000 is calculated to represent the cost of purchasing, reconstructing, and equipping the tramways, while the remainder is the expenditure required for street improvements, which would be entirely in the borough of Lambeth.

The local authorities have been approached by the London County Council to ascertain whether they will consent to the adoption of the overhead system for the lines, excepting those in South Lambeth-road, and the Lambeth Borough Council has been asked to agree to contribute one-third—or about £10,450—of the net cost of the necessary street widenings for the reconstruction of the tramways. The Camberwell Borough Council has given its consent to the installation of overhead wires on the short portions of the tramways in that district, but the Lambeth Borough Council has not yet arrived at a decision. If, however, the latter adheres to previous resolutions in regard to electric tramways, it will refuse to approve of the employment of the overhead trolley system on the lines in question; and if the Borough Council maintains its former policy, it will also decline to contribute towards street widenings which are only necessary for the purpose of the tramway service, and not for the general vehicular traffic of the locality. As the Highways Committee have unanimously decided not to recommend the County Council to purchase the tramway undertaking unless the Borough Council accepts the conditions relating to the use of overhead wires and the payment of £10,450 towards the cost of widening the roads, it is probable that the scheme will be abandoned if Lambeth remains true to its past traditions, more especially when the differences are remembered which arose between the two parties regarding the widening of the Kennington end of Brixton-road to relieve the block caused by the cable cars at that spot. It is this insistence upon contributions by the local authorities which is retarding the progress of tramways in various parts of London. Since the foregoing lines were written the Lambeth Council has apparently reversed its former policy, as it has agreed to the use of overhead wires and to make a contribution of £20,000 towards the street widenings.

The disorganisation of the traffic caused by the change from cable car to electric car at the Kennington Park end of Brixton-road is now proposed to be remedied as rapidly as possible. It is intended to reconstruct the Brixton-Streatham cable line on the conduit system, and to commence the work early next year. When the contract has been placed the work will be carried through with as much expedition as is practicable, both in order to minimise the inconvenience caused to the residents along the route by the disturbance of the carriageway, and also to ensure, if possible, the completion of the lines before the beginning of the heavy summer traffic. The cost of the roadwork is estimated at £90,000, and of the rails £17,300, while the cars have already been ordered and a number delivered. It is proposed, pending the construction of the generating station at Greenwich, to make temporary arrangements for the supply of power for working the Brixton-Streatham lines. The decision to proceed with the reconstruction of these tramways at an early date will be welcomed by the large population affected by the service.

THE last day for receiving entries for the Gordon Bennett Selection Trials is December 31st.

PROGRESS OF WARSHIPS AND MACHINERY BUILDING IN ENGLAND.

IN the opening paragraph of our last article under the above heading in the issue of this journal of 3rd July we stated that we feared some time would elapse before the contract would be placed for the construction of the new type of battleship for the British Navy, intended to eclipse in size, speed, and gun power anything previously attempted in warship building. This vessel was to be the first of three 18,000-ton battleships—the designs for which are said to be completed—which would consequently be the largest of that class of ship in the world. Since the above mentioned intimation appeared in our pages the intention to ask for tenders for the building of these large ships has been very prudently deferred; the delay, however, not being dependent on the feasibility of their construction, but whether they could be docked for completion or repair after they are built, as there is at present in the United Kingdom or elsewhere no dock large enough to hold them. From this fact it follows that before warships of 18,000 tons displacement are built for our Navy, we must have docks that will take them in. We may also add in connection with the building of these monster battleships that the announcement of provision having been made in the Naval Estimates for their building for the year has been in nowise received with satisfaction by either naval officers or others interested in naval progress, ships of the King Edward VII. type, of about 16,500 tons displacement, being considered of ample size for all battleship purposes.

Continuing, however, our practice of giving readers interested in naval matters a *résumé* of actual work effected in warship and machinery building in England for our own and foreign Governments, we have pleasure in again being enabled, through the courtesy of the private firms engaged in those industries, to note what has been done in their shipyards and engine works during the latter half of the expiring year. From independent sources other than official we are also able to record briefly the similar work effected in the same interval in our Royal dockyards and engine factories.

Giving, as we are accustomed to do, priority of place in our record to the work completed and in progress in the last-mentioned establishments, we have first to note that since the date—July 3rd—of our last return, the battleship King Edward VII., built at Devonport, has been launched, and the new armoured cruiser Warrior, which is to be of the Duke of Edinburgh class, has been laid down at Pembroke, her first keel-plate having been formally laid on the slipway in the dockyard there on the 5th of November last. Her principal dimensions will be:—Length, 480ft.; extreme breadth, 78ft. 6in.; displacement, 13,500 tons, at which she will have a mean draught of 27ft. She is to be propelled by twin-screw engines of 23,500 indicated horse-power, which are to give her a maximum speed of 22·33 knots.

There is also to be laid down immediately at Devonport dockyard, as soon as arrangements can be made for doing so, the Hibernia, one of the three battleships of the King Edward VII. class, for which provision is partly made in the Naval Estimates for this year. The other two similar vessels, to be named the Britannia and Africa, will be built at Portsmouth and Chatham yards respectively.

The vessels reported as still "building" are the battleship New Zealand, at Portsmouth, and the Devonshire and Duke of Edinburgh, armoured cruisers, at Chatham and Pembroke respectively.

Those, in-dockyard parlance, "completing," are the Queen and King Edward VII., battleships, and the second-class cruiser Encounter, at Devonport, the first-mentioned having commenced her steam trials, and the last being still without either engines or boilers—"making" at the Keyham factory—though launched in June, 1902. There are also "completing" at Chatham the battleships Cornwallis and Prince of Wales and the second-class cruiser Challenger, and at Pembroke the armoured cruisers Essex and Cornwall. The Clio and Cadmus, sloops, both built at Sheerness, are still in the "completing" stage.

Two new battleships — the Libertad and Constitucion—mentioned in our last report as building in this country for the Chilian navy, at Barrow and Elswick respectively, have within the past month been added by purchase to the British Navy. They are vessels of 11,800 tons displacement, and for their size are the most heavily armed and armoured vessels in the world. They are 436ft. long and 71ft. beam, and at the displacement above given will draw 24ft. 6in. With twin-screw engines of 12,500 indicated horse-power, supplied with steam by large tube Yarrow boilers, they are estimated to attain a speed of 19 knots. They have each coal storage for 2000 tons, sufficient to enable them to cover a distance of 12,000 miles at a 10-knot speed. Both vessels since purchase have been re-named; one is to be called the Triumph and the other the Swiftsure.

Turning now to the progress made in warship and machinery building in private shipyards and engine works in England in the past six months, we find the progress of work since the end of last June at Hawthorn, Leslie and Co.'s shipyard and works at Hebburn and St. Peter's, Newcastle-on-Tyne, has been as follows. The armoured cruiser Lancaster, built at Elswick, but engined at St. Peter's, has completed her machinery and other trials very satisfactorily, and will be ready for passing into the Fleet Reserve in January next. The machinery of the cruiser Cornwall, built at Pembroke, has been steamed at moorings, and her official trials will take place next month; that for the sister ship Hampshire, built at Elswick, is now being put on board. These three cruisers are all of the County class, and have propelling machinery of 22,000 indicated horse power. On the full power trial of the Lancaster a mean speed of 24 knots was attained, which is probably the highest recorded of any vessel of the County class. The machinery of the first-class cruiser Duke of Edinburgh, now being constructed at Pembroke, is being made in the shops at St. Peter's; that for the new armoured cruiser Achilles, being built at Elswick, the order for which has been recently received, is a duplicate of that fitted by Hawthorn, Leslie and Co. to the Duke of Edinburgh, with the exception that steam will be supplied by boilers of the modified Yarrow type, instead of the Babcock and Wilcox type, the engines in both ships being of 23,500 indicated horse-power. Of the new type of warships to be known as Fleet Scouts, building at Elswick, and to be engined at the St. Peter's Works, the machinery and boilers for the Adventure are in course of construction in the shops, and about ready for erection, when that for the sister ship Attentive will follow on immediately after. Each set of machinery for these two vessels is of 16,000 indicated horse-power, of the Marshall-Allan patent six-cylinder type, steam being supplied by boilers of the modified Yarrow type. Propelling machinery of 12,500 indicated horse-power, constructed at the St. Peter's Works for the Turkish cruiser Abdul Hamid, built at Elswick, is being fitted on board, and the vessel is being completed for trial. Her engines will be supplied with steam by boilers of the cylindrical multitubular type.

The three destroyers noticed in our last record—the Derwent, Waveney, and Eden—as building for the Admiralty by Hawthorn, Leslie and Co., are now finished, and have completed their preliminary trials, and are now passing through their official ones. The Eden is fitted with steam turbine machinery, which is more particularly explained further on. Orders for three more destroyers—the Boyne, Doon, and Kale—have just lately been received at the St. Peter's Works, which are to be duplicates of the Derwent and Waveney, the work on which is, of course, in the preliminary stages only.

At the works of the Parsons Steam Turbine Company at Wallsend-on-Tyne the turbine machinery of the destroyer Eden, built at the Hebburn shipyard, has been fitted on board, and the vessel is now undergoing her official trials. This machinery, which is of 7000 indicated horse-power, consists of three main turbines—one high-pressure and two low-pressure—each of which drives a shaft fitted with one propeller; but in view of the great variation in horse-power required in modern warships, two additional cruising turbines are permanently coupled to the shafts of the main low-pressure turbines, the *modus operandi* in working being as follows. When working at a low power, the steam from the boilers—which are of the modified Yarrow water-tube type—passes through the cruising turbines in series, and thence to the main turbines, so that a high ratio of expansion of the steam at all the lower speeds is obtained, and loss by throttling of the steam is avoided, suitable by-pass and admission valves being provided to the successive turbines on the down grade of the expansion curve. A by-pass admitting steam to the second stage of the expansion on the main high-pressure turbine provides means for developing an abnormal power when required without material loss of efficiency under such circumstances. The engines of the Eden, when developing 7000 indicated horse-power, are to give the vessel a speed of 25½ knots an hour.

The Amethyst, third-class cruiser, built at Elswick, and launched early in November, will be the first turbine-driven man-of-war in the British Navy. She is now being fitted by the Parsons Steam Turbine Company, with engines to develop 9800 indicated horse-power, of the same design and arrangement as those of the Eden, forced draught being applied to the boilers, which are of the modified Yarrow water-tube type. She will have two sets of turbines, one for high speed, and one for cruising speed, but being a much heavier vessel than the Eden, it is anticipated a speed of 22 knots only will be attained.

At Jarrow-on-Tyne, Palmer's Shipbuilding Company, having completed the extensive repairs it had in hand for some time of the battleship Howe, has now delivered the vessel to the Admiralty. Three of the five destroyers the firm had in hand for the Admiralty, and had launched at the date of our last record, have since run very highly successful trials. Good progress has also been made with the building of the third-class cruiser Sapphire for the British Navy. The firm has also in hand the overhaul and repair of the destroyer Flirt for the Admiralty, and has received orders for three new destroyers, which are to be 220ft. long by 20ft. 6in. beam, and to have a speed of 25½ knots. The first-class battleship Goliath, built at Chatham in 1898, and engined by the late John Penn and Sons, of Greenwich, is about to be sent to Palmer's shipyard to have a thorough overhaul.

No shipyard on the Humber being now engaged in warship building or repair, there is nothing to note until the Thames is reached, where we find that fairly good progress has been made with the building of the first-class cruiser Black Prince at the shipyard of the Thames Ironworks Company. Some delay, it will be remembered took place in the commencement of this ship, consequent on the new system of standardisation of the machinery, fittings, &c., of warships of the same class being introduced by the Admiralty, the details of that system being prepared at the Orchard Yard, where the Black Prince is being built; the construction and perfect completion of that vessel ready for commission will, however, now be steadily forwarded, she being the first warship at the Thames Ironworks whose construction has been undertaken under such conditions.

At the Company's engine works, at Greenwich, the machinery of the first-class cruiser Devonshire—building at Chatham—is well forward, the starboard engines being erected in the shops, shortly to be dismantled and sent to Chatham, while the port engines are in course of erection. The Niclausse water-tube boilers which are to supply these engines with steam are now being fitted on board. The different parts of the propelling

machinery for the Black Prince, which is to be of 23,500 horse-power, are well in hand, the cylinders and other heavy parts being now machined. The first-class cruiser Crescent, now in the Victoria Docks, has had a thorough overhaul and refit, and will shortly be ready for her steam trials.

At their new shipyard and engine works at Poplar Yarrow and Co. have in hand for the British Government six destroyers—viz., the Usk, Ribble, Teviot, Welland, Gala, and Garry—each of which is 225ft. long by 23ft. 6in. beam, and to have a speed of 25¼ knots. To be constructed in floatable sections, there are also two shallow-draught twin-screw steamers, 160ft. long by 24ft. beam—one named the Fushimi for the Japanese Government, and the other the Widgeon for the British Navy. There are also in hand for our Admiralty the water-tube boilers for the new cruiser Warrior, to be built at Pembroke Dockyard. Yarrow water-tube boilers of modified type, or with larger tubes than in express boilers, have been adopted by the Admiralty for use in the three new cruisers of 23,500 indicated horse-power, lately given out to contract, and placed with Armstrong, Whitworth and Co., Vickers, Sons and Maxim, and the Fairfield Shipbuilding and Engineering Company.

At the Chiswick shipyard and works of Sir J. I. Thornycroft and Co. the shallow-draught gunboat of the Woodcock and Woodlark type, built for the Japanese Government, has been completed, and despatched in sections to Shanghai, where it is now being put together, and fitted out for service. This vessel, which is 145ft. long by 24ft. beam, and has a draught when fully loaded of only 2ft., attained a speed of 13·37 knots on trial. She is fitted with Thornycroft patent screw-turbine propellers. The destroyer Kennet, built for the British Navy, was launched on the 4th of this month, and is now preparing for trial, and the sister ship Jed is nearly ready for launching. Two other destroyers for the same service, the Chelmer and Colne, are about to be laid down. Highly satisfactory results having been obtained with the Thornycroft petrol motor mentioned in our last record, a 30ft. launch, named the Scolopendra, has been fitted with one of 20 brake horse-power, and has distinguished itself by winning a prize cup at Cork, its speed being 18 miles an hour. A 40ft. launch fitted with a similar motor is now being built, which will be very highly powered, and will probably be entered for a valuable prize.

At Laird Brothers' shipyard and engine works at Birkenhead the four destroyers Foyle, Itchen, Arun, and Blackwater, ordered by the Admiralty last year, have successfully carried out their full power coal consumption and speed trials, and are now being hastened forward for commission. The third-class cruiser Topaze, built for the Government, has been launched, and is at present receiving her engines and boilers; her sister ship, the Diamond, being ready for launching. The repair ship Hecla, which has had a large amount of work done to her engines and boilers, has been completed and returned to Chatham Dockyard. The new machinery of 6000 indicated horse-power, constructed for the torpedo gunboat Halcyon, has been fitted on board, and the overhaul of the hull nearly completed, the vessel being nearly ready to commence her trials. The Pathfinder and Patrol, two of the new Fleet Scouts recently ordered by the Admiralty, are making good progress. Laird Brothers have also lately received an order for three more 25½-knot destroyers for the Navy, to be named the Liffey, Moy, and Ouse, sister ships to the three destroyers first mentioned as having just completed their official trials. The first-class battleship Canopus is at present undergoing a thorough overhaul in hull and machinery, at Laird's Works, and three sets of spare boilers of the Laird water-tube type have just been completed for destroyers of the Ferret and Quail classes, and are about to be shipped to the home dockyards and Malta.

LITERATURE.

Conduction of Electricity through Gases. By J. J. THOMSON. Cambridge: University Press. 1903.

(CONCLUDING NOTICE.)

JUST as a master of form created a new construction by combining the symphony and the cantata, so Professor Thomson combines the plan of the detective novel with that of the author of, we think, a book on determinants and some other more popular works. It may be remembered that throughout "The Hunting of the Snark" we are never told what a snark is. No clue is given at all; but the poem ends tragically, as the snark turned out to be a boojum after all. Similarly, no clear idea is given of the corpuscle, though the whole book is about it; but at the very end we find the corpuscle is an electron after all. The term electron is not used. We do not remember it in the whole book, but we think a corpuscle is an electron. The idea of an electron is also borrowed from the books of our youth. The Cheshire cat could disappear and leave the grin. The cat can be explained as composed of innumerable infinitesimal cats, each with an infinitesimal positive or negative grin. Once you have got down to small things you can imagine anything, so that each element may consist of grin, with no cat. Then the whole cat is really grin, and the phenomenon of cat is really the result of grin, and there is no such thing as cat at all, only grin. And if Sir Oliver Lodge says: "To me, grin is the only kind of cat possible," then it is so, and there is no more about it. Maxwell's genius really foresaw this when the cat he threw out at a top window met an equal and opposite cat.

To imagine an electron, think of a charged sphere. Let it shrink in size without losing any charge. When it has shrunk to nothing there is only the charge left as a strain in the ether. Similarly, from the idea of an electrically charged body we go to a charged corpuscle by stopping the process before completion. Then as we find the charge can give inertia, and many of the properties of what we call matter, we can conclude that the ultimate constituents may be charged corpuscles with everything but the charge non-existent. Professor Thomson does not really go so far as this. He likes a little cat with his grin. Consider a charged corpuscle. Professor Thomson takes one Faraday tube per corpuscle. This is convenient for molar work, but in considering a single corpuscle we cannot picture a single tube coming out all over it. 4π tubes would be little better. Imagine, therefore, say, 1,000,000 microtubes coming out. Engineers prefer lines, each line representing a solid angle in this case; besides, in some ways, Professor Thomson's "Faraday" tubes, as described in the *Rather Recent Researches* to which he refers, are different from those imagined by engineers. The corpuscle may be pictured as a seed of thistledown, the lines radiating out into space. If the corpuscle is moved through the ether, the radiating lines will cut the ether, causing "magnetic lines" in circles round the corpuscle, the circles travelling flatways with the corpuscle. The corpuscle will thus have what we call the inertia of self-induction, just as a fine wire has. If a wire were infinitely fine its self-induction would be infinite, similarly an electron with no size would have infinite electrical inertia. There is a great deal of speculation about electrons and corpuscles. If the inertia is all electrical, the electron must be of finite, though small, size. The idea of an electron as a charged sphere shrunk to infra molecular dimensions is itself illogical. It may be put thus. The whole idea of a charged conductor is false, it is really not a mass with a surface distribution which can slip about; it is a mass with an excess of electrons of one kind. The idea of electron or corpuscle thus wipes out the idea of surface charge slipping about. But we are told to use the exploded notion to explain the corpuscle; thus, Professor Thomson discusses the ends of the Faraday tubes slipping on the body of the corpuscle, but does not see why the corpuscle should be a conductor. A conductor is matter in which the electrons can move about. The old idea is gone. All this is not only explanation by comminution, but it is also the molar fallacy used in a self-contradicting way. To explain the familiar phenomena of conduction we are told our old ideas of molar bodies are wrong, and we must acquire unfamiliar ideas of the molar bodies, and explain them by the use of the old erroneous ideas applied to infra molecular sizes. To talk of a corpuscle as charged matter, when matter is aggregated corpuscles and molecules or atoms, is absurd. One difficulty about the electron and corpuscle is to get the inertia right, and independent of the speed. We might imagine an electron to take a little blob of ether with it. Matter will not do, if it is permeable to ether, unless it were magnetically impermeable, which is rather a contradiction in terms. Or if permeable matter, or the stuff that makes matter, composes the corpuscle, but has no inertia, the charge must be at the centre when the corpuscle is still, and must move out as it goes faster, coming out like perspiration as a high speed is attained. Then there is no reason why the component of matter, or the blob of ether—which we rather prefer—should have the same volume and shape when moving. Another question arises as to the inertia of a corpuscle at the speed of light. There is a great deal of room for discussion about this. Take our thistle-down electron, and let the seed be a blob of ether or matter stuff. It is usual to talk of starting an electron or corpuscle, apparently by pushing it or hitting it. Hitting an electron is a very crude molar notion. So is the idea that lead, and so on, stop cathode rays by inertia when "hit" by them. Our thistle seed would have all its inertia outside it. It can only be moved by having its rays infinitesimally unsymmetrical. It can only be moved by having more rays in front than behind—to an infinitesimal extent only. All its inertia and all the energy, including that of the minute charge, which does not vary, are outside it. The electron is thus rather the result of the state outside it than the cause; and we can move it only by altering the electrical and magnetic state outside it. To move it along we need to pull it by the Faraday tubes sticking out in front. At the speed of light there cannot be any such tubes, so there is no way of getting it up to the speed of light, and a greater speed is unthinkable,

There is another problem. The ether is stationary relatively to either the earth, the sun, or something else. If electrons are spheres, for example, in still ether their mutual electro-magnetic actions are the same in all directions. But suppose the ether were moving, say N. to S, or we were moving S. to N. through it, the Faraday tubes would be turned over so as to be thicker equatorially. To get over this it has been suggested that all things are really longer in the direction of movement. Thus, if the electrons are strained out into prolate ellipsoids, the tendency of the ellipsoid to have stronger fields near the ends counterbalances the effect of movement through ether, so that the external fields are those of spherical electrons in ether at rest. Everything is therefore really as in a magic mirror, or as seen through a cylindrical lens, but we do not notice it, as everything is affected equally. The universal strain theory is one of the most marvellous results of the scientific use of the imagination. Now there is no reason to suppose the universe as we know it is all there is. Our universe may be flying through space and ether at any speed. The speed may be less than light, in which case the universe we know is unconsciously distorted. But among the infinity of possible speeds, why limit our ideas to the order of v? If we are moving at the velocity of light, electrons are lines in the direction of motion, and we are all streaks reaching from where the universe started to its ultimate goal. If the speed is greater than light, we are all in duplicate, one where we started from, and the other, looking-glassed, where we are going to. These halves, if we reason aright, are flat—in two dimensions, in fact, and there is nothing between. We may be inaccurate here. Though the reviewer feels certain the idea of strained particles has been brought forward seriously, he cannot localise it, and cannot remember ever seeing it worked out in print, and has no recollection of its origin. He does not know, therefore, whether, for instance, a whole top, spinning in a northerly ether gale is elliptical, or is circular though built of strained particles. In either case, if the ether gale has the speed of light, the top must be a streak. Any reader who suffers from insomnia will find the curve of precession of a homogeniously strained top, whose inertia is partly or wholly electrical, as seen by equally strained eyes, an interesting puzzle for small hours. It may throw light on the question of the electric inertia of alleged matter.

It may be urged that we are treating a serious subject frivolously. This is not really the case. Humour depends on exhibition of the unexpectedly incongruous. It can only apply when there is something out of balance. If humour is applicable to them, so much the worse for theories of matter; the fault lies with them. We therefore write a little extravagantly in all seriousness, because the subject demands it. Human nature is the same from age to age. We now see the absurdities of the ancient philosophers, in spite of the glamour thrown over them by the apostles of classical education. We see still more clearly the absurdities of the schoolmen of the Middle Ages. But the people who discussed the density of angels on a needle point were the predecessors of those who discuss the concentration of electrical charge on an electron. But the old schoolmen were not fools; they were of the ablest of their time; and so are their successors. But the wall that exponents of unapplied science have raised to separate them from applied science does immense harm. One of the least of the evils is that it prevents their getting that sense of balance that is quickened by conflict with the world, and mixing with serious matters.

Reverting to electrons, we would suggest that they provide a field of force system that is much simpler than Professor Thomson's. He has an ether full of what he calls Faraday tubes. These sometimes start from and end on electrons, but where there are no charges near the ether is full of closed tubes. Boiled macaroni has ends to its tubes, but if we imagine them re-entrant or endless we have a crude model of his Faraday tubes in ether. Some are positive, the others negative. The closed tubes seem to have no tensile or lateral force, and no electric force along them. They can lie side by side, positive and negative, and there is no fall of potential along them. The object of their existence is simply to create magnetic field when they move.

To produce a magnetic field when there is no electric force, and therefore no ordinary tubes, Professor Thomson calls in these supernumerary tubes, the magnetic force being due to an equal passage of positive and negative tubes in opposite directions; they either slide past one another or occupy the same space simultaneously. Therefore, in case, say, of a magnetic field from a battery circuit there is an accumulation of Faraday tubes getting themselves interlinked with the magnetic circuit, and continuous unlinking of a large stock of previously interlinked tubes of the opposite sign. If a charged condenser, made of two discs rotating on an axle in the same direction, is considered, the magnetic circuit is along the axle to between the discs, and then out between them radially and round to the axle again. This machine, taking Professor Thomson a little further than he goes, is perpetually interlinking his endless Faraday tubes with circles described by the parts of the inner faces of the discs, and shedding previously interlinked tubes. The machine can collect up to any fabulous number of these tubes of one kind, shedding an equally fabulous number of the other. Yet at the end there is no stored energy and no further result whatever.

All this seems very artificial and difficult to follow.

Now take what the electron provides. An electron A alone in space has a radial displacement or polarisation, which may be represented by radial lines, say 1,000,000 micro-lines, so that the electrical displacement is shown by the density of lines anywhere. These lines, which in still ether are equally distributed radially, may each be regarded as representing a sort of conical region with a stress along it tending to shorten it, and another across it tending to thicken it. We will call these radial lines the electron's "personal lines." Now take a second electron B and put it in the field of the first. Let the second be imagined to have no lines of its own at all; we will call this a "denuded" electron. The force on it is found by multiplying the charge on B by the density of the "personal lines" of A where B is. Or B may be provided with personal lines while A is denuded, and the force A experiences from B is found. It is the same. But we may let A and B both have personal lines, and we may then map out the field so that at any point we note the resultant of the two forces. This gives a series of curved lines. If A is positive and B negative these new lines start from one and some end on the other, others go off into space. Each of these curved lines from one to the other now represents a long narrow region or bit of ether like a muscular fibre. It is in varying tension along its length, and in compression across. We can take each electron as having one fibre beginning or ending on it, or 1,000,000 micro-fibres, or fibrils. Now introduce a third electron C to the neighbourhood First let it be denuded. The force on it, if its charge is unity, is equal to the density of fibrils where it is. The electric force is thus directly proportional to the density of the fibrils there. We mention all this, because there is continual confusion about lines of force, and lines of induction, &c. There are two distinct notions; the lines that represent the fields of each charge considered separately, and the lines, tubes, or fibres which represent the resultant of the others. Exploring the fibres by means of a denuded electron is mixing the ideas in a very convenient way. The denuded electron is most convenient for calculation; the fibres for thinking about. The third electron C may have its personal

lines, and the field may then be mapped to give the resultant fibres of all these.

From this we get to the conception of each electron having one personal line, or 1,000,000 personal micro-lines, which results in its having one fibre, or 1,000,000 fibrils. All fibres or fibrils begin and end on electrons. They all have the same total fall of potential along them. These fibres can never get twisted or knotted, because though A may begin with a fibre ending on B, while C and D are connected, A can transfer to C and B to D continuously by what might be called by the logically sounding name of distributed middle. In such a case as the steady magnetic field, every time an electron goes round a circuit its fibre must cut the magnetic circuit somewhere once. If there is a small electric field—that is to say, small density of fibres—the fibres must cross more quickly. The limit is no fibres and no field and infinite velocity of crossing. But the fibres must cross somewhere, and there seems to be no way out of that. The infinite velocity need give no trouble. In the case of the discs the electrons on the discs have some of their fibres going across, but all the fibres must cut the magnetic circuit somewhere.

We put this forward as a suggestion. Professor Thomson is a specialist in these matters, we are a casual, perhaps not too casual, reviewer; and the suggestion seems worth making. It cannot be worked out here, of course.

Finally the electron or corpuscle theory is of enormous importance. The engineer may say that unapplied science is raw material, and though it is the business of engineers to take the raw material of knowledge as produced, and work it up into useful and beautiful forms as the silk spinner works up the output of a worm into gorgeous raiment, this material is too raw and crude even to make a silk purse. Here we differ. The theory of electrons comes into use at once in electrolysis, and the arc. Electrolysis is not treated in this book; but one treatise cannot deal with everything. But the electron theory is one of the most far-reaching conceptions of science. It goes to explain or has to do with electric conduction, discharge through gases, the arc, radiation of light and heat, electrolysis, cathode rays, and therefore Röntgen rays, also Becquerel rays, many of the curious phenomena that puzzle incandescent lamp makers, spectra due to electric discharge, spectra due to flame, Zeeman effect, the Aurora Borealis, rain, mists and clouds, Hall effect, chemical action generally, chemical action of high temperatures, chemical action of ultra-violet light, helium and inert gases, inertia of matter, and perhaps matter generally, the connection between sunspots and magnetic storms, and perhaps some day it will explain gravity. These examples, jotted down at random, most likely cover only a part of the field; but that is large enough to show the great importance of the new hypothesis; and engineers who do not wish to be behindhand should study the subject, though those who have no knowledge of electricity will find the matter incomprehensible. But all must be grateful to Professor Thomson for the labour of writing this book in the middle of his pressing work, just because it was urgently wanted.

SHORT NOTICES

The Automobile. New and enlarged edition. Edited by Paul N. Hasluck. London: Cassell and Co., Limited.—The growth of the motor car movement can be well gauged by the increase in girth of the second edition of this book, which has been called for in less than a year and a-half. The editor has found it necessary to add over 500 pages of new matter, including over this number of illustrations. He says in his preface that "an attempt has been made to describe every noteworthy make of British and continental car. . . . whilst some of the most representative American constructions are also treated in detail." He has also retained all the valuable information which he acknowledged in the earlier edition as being taken from Gérard Lavergne's French work entitled "Manual Théoretique et Pratique de l'Automobile sur Route." It would be difficult to name any well-known type of motor vehicle which is not included in the present volume, and generally the information is "up to date." This, however, is not wholly true, for some of the vehicles have undergone considerable modification since the drawings by which they are illustrated were produced. Other vehicles included have already disappeared into oblivion, but the particulars concerning them have a certain amount of historical interest, while others need scarcely have been included. The chapter on the construction and operation of the petrol motor is very complete and interesting, especially that portion which deals with two-cycle motors. Of these there are several that appear to have passed the experimental stage, and of which more will probably be heard at no very distant date. The chapter on steam boilers and motors is also fairly complete, but the drawing of the Chelmsford steam engine does not represent this motor as it is now being manufactured. The chapter on carburetters has been extended since the first edition was written, and now includes such recent novelties as the Krebs petrol carburetter and the Moorwood-Bennet instrument for gasifying petroleum. The interesting chapter on traction resistances has been added to by including an abstract from a report prepared by Professor H. S. Hele-Shaw, and presented at the meeting of the British Association last year. In the chapter devoted to steam automobile carriages, the Leyland steam lorry described is of an obsolete pattern; but on the whole, the editor has succeeded in compiling a book which will be found acceptable to all interested in the self-propelled traffic problem. The illustrations are generally of good quality, and the copious index now provided is a decided acquisition.

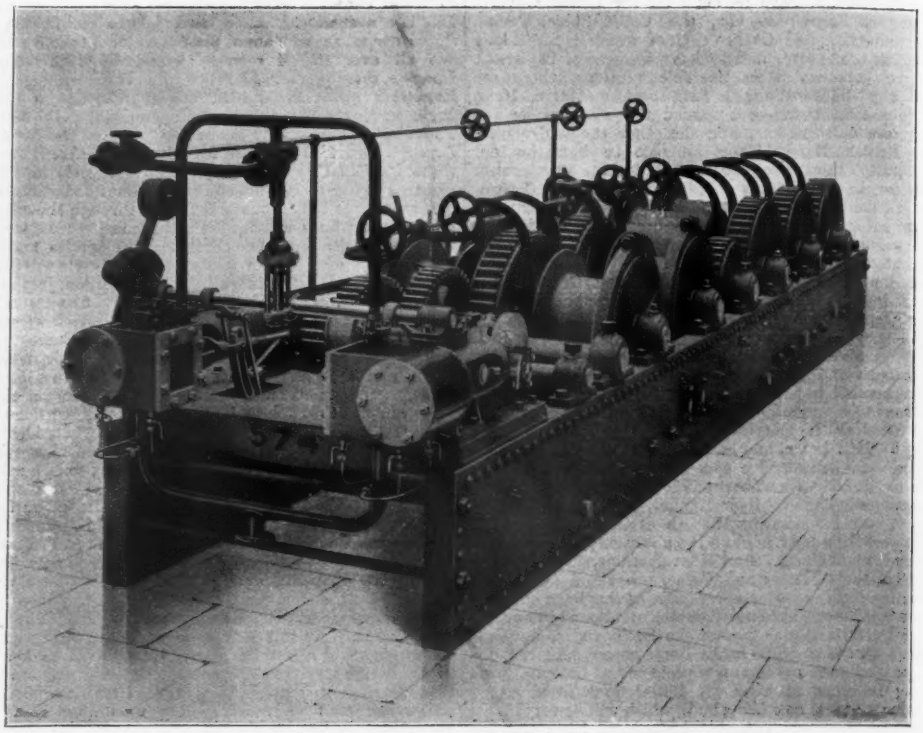
Notes on Permanent Way Material, Plate-laying, and Points and Crossings, with a few Remarks on Signalling and Interlocking. By W. H. Cole, M. Inst. C.E. Fourth edition, revised. London: E. and F. N. Spon. 7s. 6d.—As all who are interested in railway matters should know by this time, Mr. Cole's book is an excellent little work on the construction of permanent ways. The fourth edition, which brings the book up to date, is therefore heartily to be welcomed.

ROYAL NATIONAL LIFE-BOAT INSTITUTION.—Owing to the expiration of lease, the Committee of Management have been compelled to remove the headquarters of the Institution from 14, John-street, Adelphi, London, where they have been situated for the long period of forty-eight years, to 20, Charing Cross-road, London, W.C. The Institution since its establishment in 1824 has granted rewards for the saving of upwards of 44,000 lives from shipwreck on the coasts of the United Kingdom. Help is much needed to efficiently carry on this great national life-saving service.

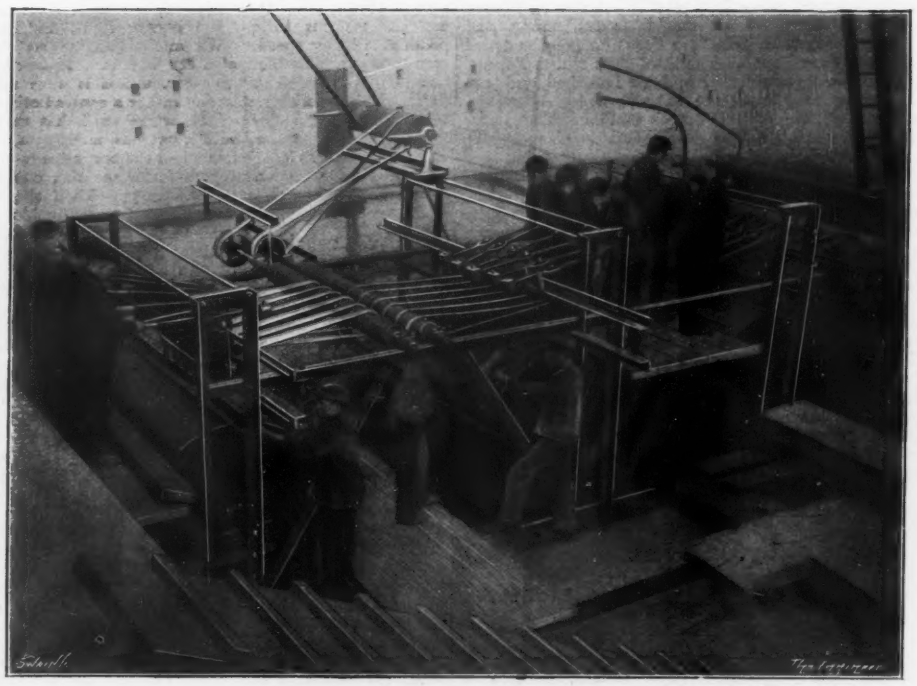
MACHINERY FOR GOLD DREDGERS

LOBNITZ AND CO., LIMITED, RENFREW, ENGINEERS

(For description see page 625.)



MANŒUVRING WINCH



SCREEN DRILLING AND TAPERING MACHINE

SHIPYARD APPRENTICES.

THE most important business at the meeting of the North-East Coast Institution of Engineers and Shipbuilders, held at the Literary and Philosophical Hall, Newcastle, was the reception of the report of the Education Committee which has been considering the training of apprentices.

In an explanatory note the committee explained that they were of opinion that youths intending to qualify as artisans should receive while at school the best training possible, and that all school lads should have inculcated habits of order, perseverance, and good conduct, and that the development of these studies and habits should be encouraged in the workshop by rewards offered.

The committee also expressed the belief that the industrial conditions in the country call for some change in the methods of selecting and training those destined to work in the higher branches of engineering and shipbuilding.

To achieve this the committee put its recommendations in the form of regulations for adoption in works, these being divided into the heads of "ordinary apprentices" and "pupils," of which latter they think each works should average taking two fresh ones a year, which, for six years' pupilage—each being at college three years—will work out at six being in the works at a time, the increase in wages being £40 a year.

APPROVED EXAMINATIONS.

For apprentices the committee recommends a system of marks for passing approved examinations, for time-keeping and for good conduct, perseverance, and progress in the workshops, these marks entitling an apprentice to proportionate increases of pay in each year. Further, that promotion depend upon marks obtained, and that a successful apprentice be allowed to spend his fourth and fifth years at college day classes, the employer paying the fees.

For pupils it is suggested that after a three years' engineering course youths be taken into the works for three years' pupilage at enhanced pay.

Or, as an alternative, that they combine workshop experience and college study, going through six years' pupilage, out of which they spend three academical years in attending the degree course of study at a University College, getting enhanced pay after the first year's college pay.

The report was unanimously adopted.

ALMANACS AND CALENDARS FOR 1904.

THE latest batch of these seasonable publications include a wall calendar with large-sized and easily legible figures from Messrs. George Cradock and Co., Wakefield; a tasteful calendar from the Trent Navigation Company, with a well-printed view of the river Trent and fleet of steam barges; a block calendar with daily tear-off slips from Messrs. E. R. and F. Turner, Limited; a similar type of calendar from Henry Simon, Limited, with the usual trite sayings and well-chosen quotations from classical authors; and a calendar from Messrs. Dickson and Mann, Limited, of Armadale, Scotland, the date cards of which are surrounded by illustrations of this firm's manufactures.

LONDON, BRIGHTON, AND SOUTH COAST RAILWAY—BALHAM TO CROYDON WIDENING

MR. C. L. MORGAN, M. INST. C.E., LONDON BRIDGE, ENGINEER

(For description see page 623)

Fig. 1—STREATHAM COMMON VIADUCT AND CROSSING

Fig. 2—BEULAH BRIDGE

Fig. 3—THORNTON HEATH STATION

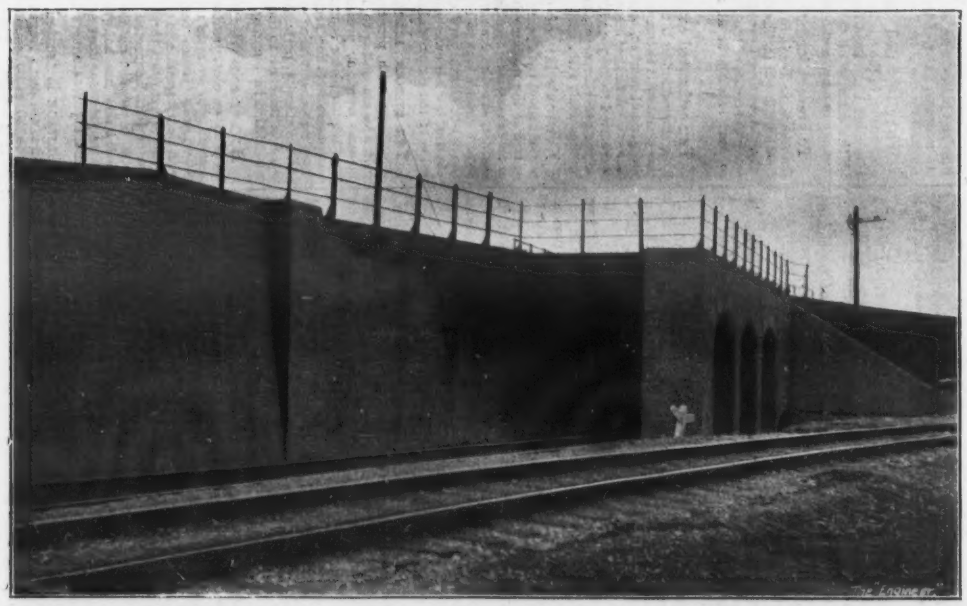


Fig. 4—THE FORK BRIDGE

RAILWAY MATTERS.

IT is expected that the Agra-Delhi chord line of the Indian Midland Railway will be opened towards the end of 1904.

THE Canadian Pacific Railway Company will build an extension west, from Lipton, Man., across Loon Creek, next spring.

ACCORDING to a recent issue of the *Journal de St. Pétersbourg*, the survey of the proposed line between Kiakhta and Pekin, *viâ* Ougra—1500 versts—has been completed.

As a result of agitation on the part of season ticket-holders, the London and North-Western Railway Company has promised some improvement in the service between Manchester and Rhyl, Colwyn Bay, and Llandudno.

ACCORDING to reports, arrangements are practically completed for the construction by the Chicago, Rock Island, and Pacific Railroad of a line across Iowa between Davenport and Council Bluffs. The distance will be shortened considerably.

A DESPATCH has been received, through the Foreign-office, from the British Vice-Consul at Sevastopol, reporting that the Russian Government had decided to construct an electric railway between Sevastopol and Yalta, to pass, *viâ* Balaclava, Bida, Aloupka, and Livadia.

OWING to a fog which prevailed one day last week, two electric tramcars came into collision during the afternoon in the outskirts of Paris. Both cars were wrecked and nineteen persons were injured, seven of them seriously, including the two drivers and the two conductors.

A NEW surface-contact system of electric traction as applied to railways was put on trial recently in America on a mile of experimental line on the Pennsylvania Railroad. Report states that a speed of 85 miles an hour was attained, and that in other respects the results were successful.

THE Cheshire Lines Committee have in hand the erection of a new passenger station at Trafford Park, Manchester. The official opening will take place on Monday, January 4th, from which date about twenty-one trains, running in each direction, will call at the new station daily, and on Sundays about ten trains in each direction.

THE Atchison, Topeka, and Santa Fé Railroad has purchased the Cane Belt Railroad, running from Sealy, Texas, to Matagorda, 90 miles. The building of a line to be called the Eastern Railway of Mexico, which will be about 500 miles long, and cost 13,000,000 dols. to 14,000,000 dols., is contemplated; also a line north from San Francisco.

THE Belgian Commission in Cuba, in a report to the Department of Foreign Affairs in Brussels, says that Cuba is an excellent market for automobiles owing to their constantly increasing use. The most popular type is the voiturette, and the Commission recommends a strongly-built car of about 10 horse-power, able to stand the poor roads, and moderate in price.

SINCE the Tsar of Russia paid a visit last summer to the shrine containing the bones of Saint Seraphim there has been a continuous stream of devout pilgrims to Saroff. As it is expected that the place in question is destined to become a centre of attraction to people in all parts of the Empire a company has been formed for the purpose of building a line of railway from Arsamas or Shotki to Saroff, at an estimated cost of £220,000.

ON Friday last at Derby the principal officials of the Midland Railway Company entertained to dinner Mr. S. W. Johnson, locomotive superintendent, who is retiring into private life at the end of the year after thirty years' service with the company, and at the same time presented him with a handsome silver tea and coffee service and salver as a token of the great regard in which he is held by them. The chair was occupied by Mr. John Mathieson.

A BRAKE shoe is being constructed by an American firm having a hard iron insert around which is cast the body of the shoe in gray iron. The gray iron is not permitted to chill, which is claimed to be a peculiarity of this shoe as compared to others of the kind. The hard iron is made of very high-grade malleable iron. The secret processes of casting gray iron about the insert without chilling are said to give toughness to the body of the shoe, and a better friction coefficient than a chilled shoe.

THE Pennsylvania Railroad Company has ordered the resumption of work on portions of its improvements and new lines, which was stopped a few weeks ago. The work between Columbia, Pa., and Parkesburg, between Paoli and Thorndale, and at Newport will be held up until spring. This includes some £6,000,000 in improvements. The new four-track system through the Greensburg section will extend from a point east of Radebaugh to Beatty, 8½ miles. Several tunnels will be necessary along the line, and the cost will amount to about £400,000.

IN the report for the year 1902 on the railways in the Straits Settlements it is pointed out that in Perak an addition of 30 miles 3 chains was made to the open line during the year, bringing up the total mileage open for traffic to 274 miles 40 chains. These established through communication between Penang and Taiping, thence the line is open to Bukit Gantang, where there is a break for 7½ miles—which will be completed during the first half of the current year—communication being resumed at Padang Rengas *via* Kuala Kangsar to Ipoh and Bidor. The total mileage of open line from Penang to Bidor is 146 miles.

IN the next session of Parliament powers are to be sought for to take over the Stockport and Hazel Grove system of electric tramways and to extend it from Hazel Grove on to Macclesfield by way of Adlington, Poynton, and Butley, skirting Prestbury. The system will run on to Broken Cross at Macclesfield, and it is proposed also to establish an electric car system in that borough. The present line from Stockport to Hazel Grove is four miles in length, and under the new scheme fourteen miles will be added. If the scheme is carried out there will be a practically continuous line of tramway from Manchester to Macclesfield.

THE Selangor railway extension to Tanjong Malin was finally completed on December 31st, 1902, and on April 2nd, 1903, the extension through Negri Sembilan to Seremban was opened for traffic, a distance of 28¾ miles. At Seremban the State line connects with that of the Sungei Ujong Railway Company, giving access to Port Dickson, distant by rail 25 miles from Seremban. The extensions sanctioned some years ago were to be completed during the current year. They aggregate 179½ miles, and were commenced in June, 1896. During the year under review 2,734,978 dols. were expended on construction, and 50,828 dols. on surveys in Negri Sembilan.

IT is stated on good authority that the Liverpool Overhead Railway Company has entered into a working agreement with the Lancashire and Yorkshire Railway Company, under which the Overhead Railway will be extended from Seaforth Sands Station, and a physical connection made with the Lancashire and Yorkshire station at Seaforth. The Act for this was obtained in 1900, and negotiations have resulted in the foregoing satisfactory arrangements. Seeing that the Southport branch of the Lancashire and Yorkshire Railway is now being electrified, the importance of this arrangement is increased, as the agreement provides that the Lancashire and Yorkshire trains shall run over the Overhead Railway Company's system, and the Overhead trains over the Lancashire and Yorkshire lines.

NOTES AND MEMORANDA.

ON the subject of paper insulation the American Steel and Wire Company has made extensive tests with paper insulated wire and cables with results that are considered very important. As a consequence of these tests this paper insulation has been adopted for the New York underground system.

WHAT is stated to have been the longest drought ever known in the South-West of North America was broken on December 1st. The drought lasted 82 days at New Orleans, but in the interior of the South-West it lasted 120 days, causing damage to crops and heavy losses from forest and field fires.

TO prevent further disasters such as that which visited Galveston, in Texas, in 1900, when 3000 houses were destroyed and 8000 lives lost in the floods, it is proposed to raise the whole of the city. According to the present plan, earth is to be brought from along the coasts of the Gulf and banked upon the site of the city, so that it shall be at a level of from 17ft. to 20ft. above the sea.

THE estimated capacity of the new blast furnace plants to be started in the U.S.A. in 1904 is about 2,000,000 tons, and of this quantity it is computed that 905,000 tons will be for sale in the general market, which may mean increased competition in Europe. A further increase of capacity, equalling 2,425,000 tons, is credited to the year 1904, of which 405,000 tons will be thrown on the general market, so that a total of 1,310,000 tons is likely to be thus dealt with.

NEWTON'S law of gravitation, which states that two bodies attract each other with a force inversely proportional to the square of the distance between them, has been made the subject of an exhaustive investigation by Professor Brown, of Haverford College, says the *Iron Age*. He announces that his calculations show Newton's laws to represent the motion of our moon to within the one-millionth part of 1 per cent., and states that no other physical law has ever been expressed with anything like the precision of the simple statement of this one.

THE armour manufactories of the United States, in accordance with promise, have added to their facilities, and deliveries amounting to 11,493 tons have been made—a marked increase over any previous year. We learn from the *Iron Age* that armour plates are now tested with capped projectiles. The acceptance tests for armour-piercing projectiles have been made more rigorous, it being now required that they shall, at a prescribed velocity, perforate unbroken a plate of hard-faced armour equal in thickness to the diameter of the projectile, and then be in a condition for bursting.

ROTARY converters operated six-phase will give from 35 to 45 per cent. greater output than when operated three-phase, according to an article by Mr. A. S. M. Allister in the *American Electrician*. Hence economy dictates three-phase transmission, with transformation to six-phase at the converters. The simplest method is to use three transformers, the primaries being either star or delta connected and the secondaries star connected. A delta connection on the low-tension side, as well as on the high-tension side, has, however, the advantage that the breakdown of one transformer does not render the plant useless, as the two remaining transformers take the load of the missing one.

SEWAGE is treated in Brünn, Moravia, by a chemical process utilising a reagent composed of 1 kilogramme of organic carbon, 20 to 30 grammes of lime, and 10 of zinc dust per cubic metre of sewage. The carbon is obtained by dry distillation in gas retorts of offal from abattoirs. After mixing with the proper dose of the reagent, the sewage flows into a settling basin, from which the deposited mud is pumped to filter presses. The press cakes are distilled dry and a part of the reagent can be recovered. From the settling basin the turbid water flows to a filter consisting of superposed layers of brick, coke, and carbon. From this filter the clarified effluent is turned into the river.

THE recently published official statistics show that on December 31st, 1901, there were in the Russian Empire 17,786 industrial establishments employing 1,710,735 workpeople, of whom 73·2 per cent. were males, and 26·8 females: the adults numbered 89 per cent., half-grown persons 9 per cent., and children 2 per cent. The number of women workers increased somewhat in 1901 as compared with the males, especially in cotton mills, match factories, and tobacco factories. The factory inspectors, of whom each one had to visit on an average 86·6 establishments, made 12,813 visits of inspection during the official year. Thus, only about 70 per cent. of all the manufactories were visited officially.

AN instance of where brute strength triumphs with the modern wire-drawer as a wage-earning factor, as compared with the skill of the old time wire-drawer, who had to make his own dies as well as draw his wire, is shown in the case of the champion of the Worcester works of the American Steel and Wire Company, who, according to the *Iron Age*, draws 10,000 lb. of three draft wire a day. This man is a Finlander of enormous strength and endurance. To draw 10,000 lb. of wire means to lift 40,000 lb. a day, 200 lb. at a time. The wire is drawn from No. 5 to No. 12½. He must lift the rod on the reel, then lift the coil off the block on the reel, for the second draft; repeat this operation, and finally lift the coil off the block on a barrow.

IN nickel wire Mr. E. Williams finds that the effect of stretching is to diminish the magnetic change of resistance in low fields and to increase in high fields. In the finer wires the change of resistance is smaller in low fields and greater in high fields than in the thicker wire. The effect of stress is much smaller in iron than in nickel, and there is hardly any effect in the highest fields. In platinite, the highest value in the change of resistance is rather greater than in the case of iron, the curve being, however, of a very different shape. As regards temperature, it has the greatest effect upon the change of resistance in platinite, and the least in iron. In every case, according to Mr. E. E. Fournier d'Albe in the *Electrician*, there is a diminution of the change on annealing.

AT a meeting of the Physical Society of London on December 11th a paper on "A Method of Mechanically Reinforcing Sounds" was read by the Rev. T. C. Porter. If a tuning-fork be sounded and placed in a flame there is a very marked reinforcement of the sound. This is proved not to be due to resonance in the ordinary sense, but to the change from continuous to intermittent combustion. Under certain circumstances the impulses given to the air external to the flame, by the waves of burning gas, are more forcible than those given by the unaided sounding body. Thus a new way of reinforcing the sounds given by a vibrating body is found; and the rest of the paper demonstrates this for the phonograph, a flame being used instead of the ordinary trumpet.

THE richest deposits of manganese ore in the world are in the Government of Kutais, in Transcaucasia, on the Black Sea. These deposits are estimated to be 85 square miles in extent, and to contain 238,095,238 tons of ore in a seam of an average depth of 2ft. The centre of the industry is the village of Chiatung, in the district of Sharopan. Since 1893 a small-gauge railway has connected Chiatung with the Transcaucasus main line. The working of these deposits was begun in 1879, and since that year 2,911,111 tons of manganese ore have been produced. Of that quantity Russia has used only 8·42 per cent., and the remainder has been exported to Western Europe and to America. The leading buyers of the ore have been Great Britain, 36·12 per cent. of the output; Holland, 29·14 per cent.; and the United States, 14·70 per cent.

MISCELLANEA.

THE Corporation of Doncaster are seeking powers to borrow £9920 in connection with the extension of their electricity works.

TOWN and harbour improvements for Rio de Janeiro have been approved by the President of the United States of Brazil. The proposed works will cost a very large sum.

FIFTY-FIVE towns or villages in Germany are artificially illuminated by acetylene gas, and the total length of the mains is 145 miles. The price of the gas varies between 1s. 6½d. to 2s. 3d. per cubic metre.

THE North-Western Power Gas Company has deposited plans with the town clerk of Glossop for acquiring a plot of land on which it is proposed to build a new generating station, near Woolley Bridge-road, Hadfield.

THERE is a proposal on foot to establish an Institution of Motor Engineers in this country. The Cycle Engineers' Institute is at present the only body which takes any special interest in motor car construction.

THE Lords of the Admiralty have decided that plans which were approved some time since for the conversion of land known as Burrow Island, on the Gosport side of Portsmouth Harbour, into a coaling depôt shall be proceeded with.

AT the forthcoming St. Louis Exhibition the United States Steel Corporation will make an exhibit that will cover two acres of floor space. It will be the first exhibit of so wide a scope ever attempted, and will cover every branch of the industry.

THE Russian Board of Mercantile Shipping and Harbours is working out a project to connect the White Sea, near Soroka, with Lake Onega, near Powyenetz, by means of a canal, which would be 135 miles in length, and which would cost £1,320,000.

A YIELD of 5 cubic feet of acetylene gas from every pound of calcium carbide is guaranteed by manufacturers in the United States. In Germany acetylene gas is mixed with a gas of lower candle-power, containing about 25 per cent. acetylene, and used in railway cars.

AT the exhibition of motor cars in Paris the Ducommun 24 horse-power car has a motor fitted with automatic induction valves made in one piece, the valve ring and guide being formed in halves so fashioned that upon the valve and its seating being withdrawn from the valve-box the valve itself can be detached and quickly replaced.

THE authorities in charge of the telephone service in Japan have decided to employ only girls, both for day and night duty, at the various exchanges. Men were formerly employed for night work, but this arrangement proved unsatisfactory. This branch of the service gives employment to 3017 hands, of which number 1129 are girls.

THE total energy generated and used at the St. Louis Exhibition will be close upon 50,000 horse-power. Over 80 per cent. of the electric energy will be in 6600 volt, three-phase, 25-cycle current. The largest unit will be an 8000 horse-power steam turbine, and the next largest a 5000 horse-power compound horizontal and vertical reciprocating steam engine.

THE United States Navy Bureau of Steam Engineering is about to place an order for nickel steel boiler tubes and condenser tubes, to be installed on one of the vessels plying in home waters, so that the tests which will be made can be under constant supervision. A careful comparison will be made of this material and the simple steel tubes now in use.

THE chairman of the Mersey Dock Board, at the meeting last week, said that, in addition to the graving dock now being constructed, 800ft. long, another would be at once commenced 630ft. long. New dock entrances would be provided for the largest steamers in the world—even those the Americans talked of building, which would be 800ft. long and of proportionate breadth. Since July there had been an increase of 673,000 tons and £60,000 in receipts.

THE battleship Hindustan, of the King Edward class, was launched on Saturday from the yard of John Brown, Limited, Glasgow, the christening ceremony being performed by the Duchess of Connaught. The principal dimensions are:—Length between perpendiculars, 425ft.; breadth moulded, 78ft.; draught of water amidships, 26ft. 9in.; displacement, 16,350 tons. The launching weight of the vessel was over 8000 tons. The Hindustan is the thirty-fourth warship launched from this yard in eighteen years.

LAST week a deputation from the Roads and Bridges Committee of the Kent County Council visited Sandgate, and inspected Battery Point, where the sea has made such ravages that the tramway service between Sandgate and Seabrook has had to be suspended. The necessity of immediate steps being taken to save the roadway was recognised, and it is understood that a strong recommendation to the Kent County Council to this effect will be made. It is expected that the work will embrace the construction, at the expense of the county, of a considerable length of new sea wall.

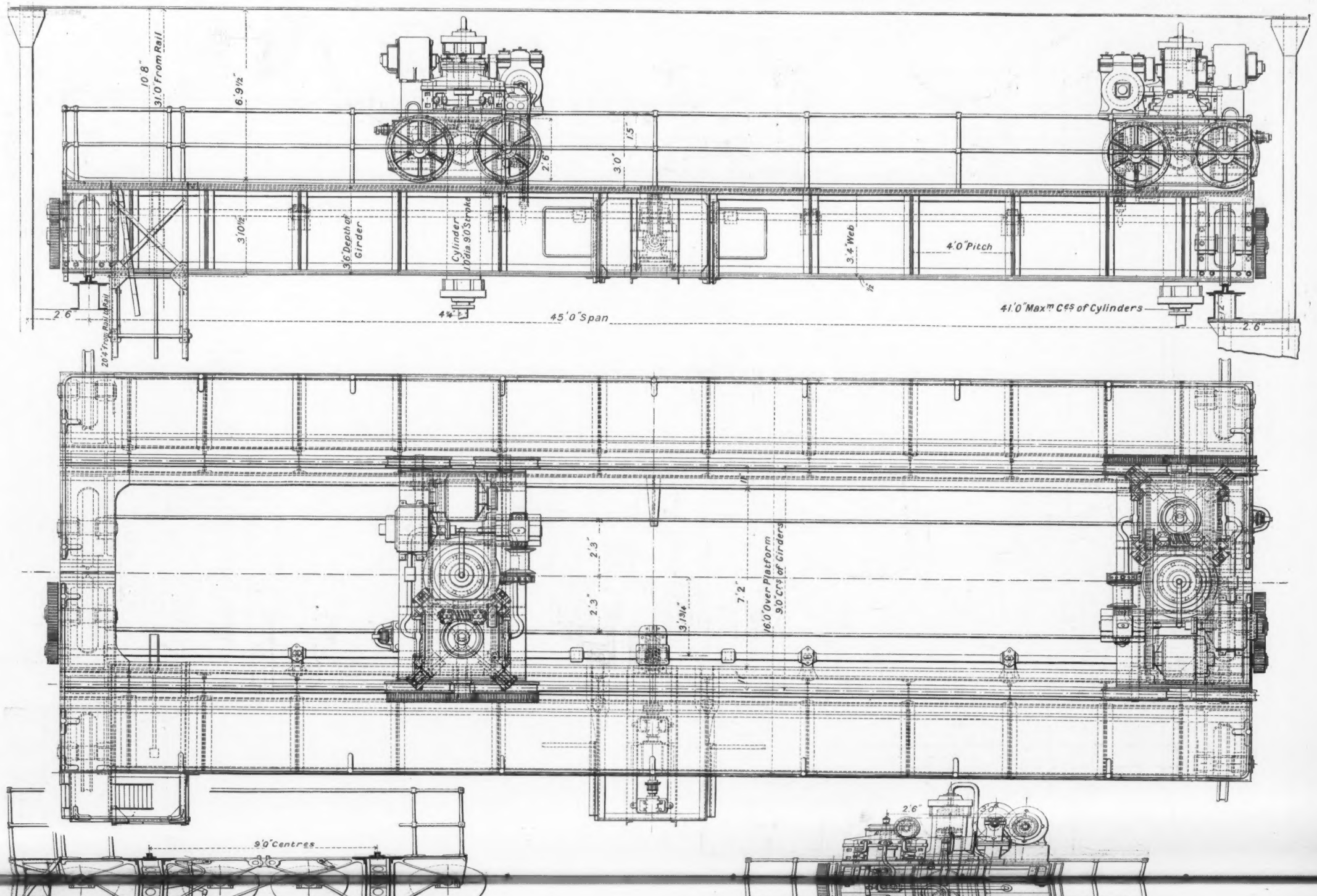
THE chief use for acetylene in Canada is as an illuminant in private dwellings, the acetylene being a cheaper source of illumination than gas or electricity. On the river St. Lawrence the buoys are lighted with acetylene gas, the gas being compressed into the buoys under ten or more atmospheres. The gas passes from the reservoir to the burner through a reducing regulator. The buoys are sufficiently large to supply gas to the burner for from three to six months without recharging. The buoys can be recharged without being removed from their positions, a steamer with a specially constructed generating apparatus and a pump for compressing the gas being employed for this purpose.

THE industrial development of Brazil is likely to be greatly enhanced by the recent discovery of coal measures in that country. The monthly bulletin of the International Bureau of the American Republics for September reports that there has been discovered in Brazil, at a place called Cedro, in the township of Imbituba, State of Parana, a great deposit of coal. The coal-bearing area extends over 3000 hectares (7000 acres), and the samples taken from the upper strata were classified as "fat pit coal." These coalfields run through the centre of Parana due north and south, and seem to be the continuation of the vein that traverses the States of Rio Grande do Sul and Santa Catharina.

A NEW use for calcium carbide, for raising and sinking a submarine boat, has been found in Germany. The boat is supplied with an ordinary gas generator and a water tank, the upper part of which is connected with the gas reservoir of the generator. The tank and the generator have pipes at the bottom opening into the sea water. The upper parts have vertical pipes for the escape of the gas. If the tank and the reservoir of the generator are filled with water, the boat sinks. After the introduction of a carbide cartridge into the gas generator an immense quantity of gas is formed at once, which forces the water through the lower pipe into the sea. After opening the cock in the connecting pipe, the gas enters the tank and fills it by forcing out the water. The boat now rises to the surface, remaining there until the gas is allowed to escape from both reservoirs, which causes them to be again filled by sea water.

FIFTY-TON HYDRO-ELECTRIC CRANE

MR. G. J. CHURCHWARD, M. INST. C.E., SWINDON, ENGINEER



SCALE

"THE ENGINEER"

Copper Pipe Coiled at an Angle of 45° with both Planes

Cylinder 9'0" Stroke

From Pump

Pump Ram 2¼dia. Stroke 6"

FOREIGN AGENTS FOR SALE OF THE ENGINEER.

AUSTRIA.—F. A. BROCKHAUS, *7, Kumpfgasse, Vienna I.*
CHINA.—KELLY AND WALSH, LIMITED, *Shanghai and Hong Kong.*
FRANCE.—BOYVEAU AND CHEVILLET, *Rue de la Banque, Paris*
GERMANY.—ASHER AND CO., *13, Unter den Linden, Berlin.*
F. A. BROCKHAUS, *Leipsic;* A. TWEITMEYER, *Leipsic.*
INDIA.—A. J. COMBRIDGE AND CO., *Railway Bookstalls, Bombay.*
ITALY.—LOESCHER AND CO., *307, Corso, Rome;* BOCCA FRERES, *Turin.*
JAPAN.—KELLY AND WALSH, LIMITED, *Yokohama.*
Z. P. MARUYA AND CO., *11, Nihonbashi Tori Sanchome, Tokyo.*
RUSSIA.—C. RICKER, *14, Nevsky Prospect, St. Petersburg.*
S. AFRICA.—WM. DAWSON & SONS, LIMITED, *7 Sea-st. (Box 459), Capetown.*
GORDON AND GOTCH, *Long-street, Capetown.*
R. A. THOMPSON AND CO., *33, Loop-street, Capetown.*
J. C. JUTA AND CO., *Capetown, Port Elizabeth, Johannesburg, East London, Grahamstown, King Williamstown, Stellenbosch.*
HANDEL HOUSE, LIMITED, *Kimberley.*
ADAMS AND CO., *Durban and Maritzburg.*
AUSTRALIA.—GORDON AND GOTCH, *Melbourne, Sydney, and Brisbane.*
R. A. THOMPSON AND CO., *180, Pitt-street, Sydney; Melbourne Adelaide, and Brisbane.*
TURNER AND HENDERSON, *Hunt-street, Sydney.*
NEW ZEALAND.—UPTON AND CO., *Auckland;* CRAIG, J. W., *Napier.*
CANADA.—MONTREAL NEWS CO., *386 and 388, St. James-street, Montreal.*
TORONTO NEWS CO., *42, Yonge-street, Toronto.*
UNITED STATES OF AMERICA.—INTERNATIONAL NEWS CO., *83 and 85, Duane-street, New York;* SUBSCRIPTION NEWS CO., *Chicago.*
STRAITS SETTLEMENTS.—KELLY AND WALSH, LIMITED, *Singapore.*
CEYLON.—WIJAYARTHA AND CO., *Colombo.*

SUBSCRIPTIONS.

THE ENGINEER can be had, by order, from any newsagent in town or country, at the various railway stations; or it can, if preferred, be supplied direct from the office on the following terms (paid in advance):—

Half-yearly (including double number) .. .. £0 14s. 6d.
Yearly (including two double numbers).. .. £1 9s. 0d.

CLOTH READING CASES, to hold six issues, 2s. 6d. each, post free 2s. 10d.

If credit occur, an extra charge of two shillings and sixpence per annum will be made.

Foreign Subscriptions will, until further notice, be received at the rates given below. Foreign Subscribers paying in advance at these rates will receive THE ENGINEER weekly and post free. Subscriptions sent by Post-office Order must be made payable to THE ENGINEER, and accompanied by letter of advice to the Publisher.

THIN PAPER COPIES.		THICK PAPER COPIES.	
Half-yearly	£0 18s. 0d.	Half-yearly	£1 0s. 3d.
Yearly	£1 16s. 0d.	Yearly	£2 0s. 6d.

(The difference to cover extra postage.)

ADVERTISEMENTS.

☞ The charge for advertisements of four lines and under is three shillings, for every two lines afterwards one shilling and sixpence; odd lines are charged one shilling. The line averages seven words. When an advertisement measures an inch or more, the charge is 10s. per inch. All single advertisements from the country must be accompanied by a Post-office Order in payment. Alternate advertisements will be inserted with all practical regularity, but regularity cannot be guaranteed in any such case. All except weekly advertisements are taken subject to this condition.

Advertisements cannot be inserted unless delivered before Six o'clock on Thursday evening; and, in consequence of the necessity for going to press early with a portion of the edition, ALTERATIONS to standing advertisements should arrive not later than Ten o'clock on Tuesday morning in each week.

Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

Telegraphic Address, "ENGINEER NEWSPAPER, LONDON."

PUBLISHER'S NOTICES.

*** **During the rebuilding of the house, No. 33, Norfolk-street, "THE ENGINEER" will be edited and published in Temporary Offices, Nos. 2 and 3, Norfolk-street, to which all communications for the Editor or Publisher should be addressed.**

*** *With this week's number is issued, as a Supplement, a Two-page Drawing of a 50-ton Hydro-electric Crane at Swindon. Every copy as issued by the Publisher includes a copy of this Supplement, and subscribers are requested to notify the fact should they not receive it.*

*** *If any subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

CONTENTS

THE ENGINEER, 25th December, 1903.

	PAGE
NEW FORMS OF THE STEAM TURBINE. No. II. (Illustrated.)	611
NEW VAUXHALL BRIDGE. No. III. (Illustrated)	612
MARGATE WATER SUPPLY. (Illustrated.)	614
ELECTRIC TRAMWAYS IN SOUTH LONDON	616
PROGRESS OF WARSHIP AND MACHINERY BUILDING IN ENGLAND	616
LITERATURE	617
SHORT NOTICES	618
SHIPYARD APPRENTICES	618
ALMANACS AND CALENDARS FOR 1904	618
RAILWAY MATTERS	620
NOTES AND MEMORANDA	620
MISCELLANEA	620
LEADING ARTICLES—Slipper Rails—Steel Syndicates in Russia—Municipal Trading in Electric Light—The L.C.C. and Tram Rails	621, 622
THE INSTITUTION OF MECHANICAL ENGINEERS	622
LONDON, BRIGHTON, AND SOUTH COAST RAILWAY IMPROVEMENTS. No. V. (Illustrated.)	623
50-TON HYDRO-ELECTRIC OVERHEAD CRANE. (Illustrated.)	623
BOOKS RECEIVED	623
LETTERS TO THE EDITOR	624
GOLD DREDGERS	625
THE ROLLING STOCK OF THE GREAT NORTHERN AND CITY RAILWAY. (Illustrated.)	625
A NEW FURNACE GRATE. (Illustrated)	626
TESTS OF ELECTRIC CONDUCTIVITY OF TRAMWAY CONDUCTOR RAILS	627
AN INQUIRY INTO THE WORKING OF VARIOUS WATER-SOFTENERS	627
THE INSTITUTION OF CIVIL ENGINEERS	628
LETTERS FROM THE PROVINCES—The Iron, Coal, and General Trades of Birmingham, Wolverhampton, and other Districts—Notes from Lancashire—The Sheffield District—North of England—Notes from Scotland	629
Wales and Adjoining Counties	630
NOTES FROM GERMANY	630
AUSTRALIAN NOTES	630
AMERICAN NOTES	631
LAUNCHES AND TRIAL TRIPS	631
THE PATENT JOURNAL	631
SELECTED AMERICAN PATENTS. (Illustrated.)	632

TWO-PAGE SUPPLEMENT—50-TON HYDRO-ELECTRIC CRANE.

TO CORRESPONDENTS.

☞ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

☞ *All letters intended for insertion in* THE ENGINEER, *or containing questions, should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

☞ *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

REPLIES.

J. B. (Sale).—Yes; you are quite accurate.

LOOK OUT.—You will find the whole subject fully dealt with in our next impression.

E. N. W. (St. John's Wood).—We do not fully understand your question. What class of information about fans do you require? If you will let us have some particulars as to the work you want to do, we shall be happy to assist you. At the moment we do not know whether you want to ventilate a mine or a railway carriage.

DEATH.

On the 19th inst., at Sunnyside, Weston, Bath, CHARLES CHAMBERS, C.E., age sixty-nine.

THE ENGINEER.

DECEMBER 25, 1903.

SLIPPER RAILS.

ONE of the problems to be solved by those who convert steam into electric railways is the transmission of power from the central generating station to the motors under the coaches. The operation is divided into two stages. First, there is the cable laid from the power-house to the railway; and, secondly, there is the mechanism by which the motors, while travelling at a high speed, can pick up the current. We are all familiar with the overhead trolley wire system as applied to street tramways, and, although less in evidence, the conduit system satisfying the same purpose, is fairly well understood; but for real railway work neither the wire nor the conduit seems to be favoured in this country at all events, and instead the slipper rail is used. This represents apparently extreme simplicity. A third rail in all respects like those of the permanent way, is laid in the centre of the track—that is to say under the trains. The motor coaches are provided with slippers or shoes which slide along the top of the intermediate rail, and that rail carrying current, the motors are supplied with energy from it.

We have said that apparently nothing can be simpler than this. In reality, however, the system has several defects which are not easily got over. To begin with, the slipper when travelling at a high speed tends to jump over irregularities in the rail. It must be heavy, and it is not very durable. Its progress is usually attended with a good deal of sparking which is in various ways objectionable. The rail itself must be insulated, and this in wet weather is a condition by no means easily secured, and at all times the difficulty tends to keep down the voltage. But this trouble is as nothing compared to that of bonding or bridging the gaps between the ends of the rails. It might be supposed that ordinary fish-plates screwed up hard would suffice to transmit the current. It was found out very early in the history of electrical railways that this is very far from being true, and a considerable number of patents have been taken out for improvements in methods of bonding. The rough general idea is that a strip of copper shall be secured to both rails at every joint. This seems very simple. If the fish-plate will not do, then put between the fish-plate and the rails a strip of copper, and screw up hard on that. The conditions, however, cannot be satisfied in this way. There are two principal factors to be considered; one is corrosion, the other is vibration. Let us suppose that the copper strips are quite bright and the side of the rail web polished. The copper is put in place, the steel fish-plate outside, and the whole bolted up. For a few days, or it may be hours, all goes well; then oxidation begins, and in a very short time the resistance of the joint rises. One joint means very little; but when we have 176 joints to the mile it means a good deal. Besides, it is very far from easy in practice to secure absolute metal-to-metal contact even at first. The conditions of ordinary platelaying are all against it. Again, vibration causes a slacking of fish bolts, mainly because when steel or iron is under stress, and is shaken, it tends to elongate. The reason why fish-plates become loose in permanent way is not because the nuts slack back, but because the bolts elongate. As we have said, numerous systems, some of them highly ingenious, have been patented for bonding slipper rails; none has yet been devised which is quite free from objection. As an example we name one method. A hole is bored through the web. This is rimered out at the last moment to get a clean surface. Into the hole is put the end of a bit of copper wire cable. Then a tapered pin is driven in and spreads out and flattens the wire round the circumference of the hole. The pin is usually of copper, and is riveted over at both sides. The method answers tolerably well. But, none the less, it may be said that inventors have not yet provided a quite satisfactory solution of an important problem.

It goes without saying that, if every joint in a slipper rail is a weak and costly place in the whole system, the fewer the joints the better. To secure this end is, however, not very easy, and up to the present 60ft. appears to be the economical limit of length. Rails can be rolled 30ft. long, or even more; and it is common practice now to roll 30ft. rails in four lengths and 60ft. rails in two. But there are no mills in this country which possess the plant required for finishing and straightening rails of a greater length than 60ft., because there has been hitherto no demand for anything longer. A rail 60ft. long is very unwieldy, and by no means easy to send anywhere by rail or ship. We have heard of 120ft. rails being rolled in Germany; but we fancy that they are not finished or straightened. If they are they must represent a very costly experimental order. A curious statement has been made to the effect that English rail-makers would supply 120ft. rails, provided they were not asked to guarantee a conductivity percentage, because the chemical constitution of a steel which would roll into a rail 120ft. long must be different from that of a rail 60ft. long, and the difference would be inimical to the conduction efficiency of the longer rails. It was added, moreover, that although English makers could not supply the long rails, German makers could. We have made careful inquiries, and find, as we expected, that the whole story is founded on misapprehension. It is quite true that some steels conduct better than others; but all soft steels suitable for slipper rails will roll alike.

The fact that steel does vary considerably in its conducting powers has never yet received in this country the attention that it deserves. We publish on another page an abstract of a very interesting paper on the subject read by Mr. Capp in the United States. The reason why commercial copper does not equal pure copper in conductivity is very well understood—that is, up to a certain point. But no similar knowledge is possessed as regards steel. Hitherto, indeed, there has been very little demand for information on the subject, because the slipper system has not been much used, and the trouble with joints has gone far to mask imperfections in the solid metal. It is not improbable, however, that in the near future the system which has been used with much success in the United States, of welding the ends of the rails together, will be adopted, and in that case the conductivity of the rail will become a matter of high importance.

STEEL SYNDICATES IN RUSSIA.

IT is now becoming evident that an attempt is being made to render the question of syndicates in the Russian iron and steel industry of equal importance to the prominence given to similar combinations in Germany, although in the former case the tactics adopted by such organisations only apply, or will only apply, to the inland market for the present time and the immediate future. The fact that syndicates have been or are being constituted is all the more remarkable when it is borne in mind that combinations of this kind are not only contrary to Russian law, but also that the Russian Government some time ago caused an official or semi-official protest to be published in condemnation of the syndicate policy as practised in certain other countries, the communication being largely aimed at the activity of the trade combinations existing in Germany. It is well known that M. Witte, formerly Minister of Finance, whose relations with the iron and steel producers were of an intimate character, had no friendly regard for the formation of syndicates in that country, but for some reason or other he raised no objections to the constitution which took place a few months ago of a combination of this nature under the title of the company for the Sale of Russian Metallurgical Products, and having for its object the disposal of the output of girders and U and other sections manufactured by a number of works which established the company. The last few months of the term of office of M. Witte as Minister of Finance, and the short period which has elapsed since he surrendered that portfolio, have witnessed the creation of other combinations, and it may therefore be reasonably concluded that syndicates are to be permitted henceforth either with or without official approval or restriction, provided, of

course, that the operations of these organisations do not clash with the requirements of the Government Departments in the matter of railway and shipbuilding materials. There is, however, little probability of the syndicates being able to oppose successfully the wishes of these Departments, seeing that the Government Commissions practically fix the prices which they intend to be paid for equipment and supplies.

The syndicate or company for the Sale of Metallurgical Products, which already claims to have benefited its members by advancing prices in general and in granting preferential treatment to Government Departments and certain other customers, has added to its sphere of activity the disposal of the production of the makers of sheets and plates. It has been followed by the establishment of a rolled wire syndicate, and negotiations are proceeding with a view to the constitution of a nail syndicate. In addition to this, a combination of pig iron producers has been formed in South Russia, and a scheme is being promoted for the organisation of a syndicate to include all makers of crude iron throughout the country. It is noteworthy that the improvement in the iron and steel trades of Russia, which was recorded in these columns a few months ago, has not only continued since that time, but there has also been a considerable advance in prices all round, thus showing a fairly healthy recovery from the former period of severe industrial depression. So much so, that reports are being circulated of intention to restart some of the works which had to be shut down in consequence of the crisis which prevailed down to about a year ago. It seems, however, unlikely that any practical steps will be taken in this direction in view of the arrival of the winter, which affects the iron and steel trades owing to the interruptions in the railway traffic. The perceptible improvement in the general situation may be attributed partly to the increased demand which has been experienced for iron and steel and partly to the operation of the syndicates, but it is considered that the higher prices now prevailing have practically reached their limit at the present time.

The fact that syndicates have now become officially recognised in Russia, or that hindrances are apparently no longer placed in the way of their formation, is a remarkable event in view of the past attitude of the Russian Government and the Ministry of Finance towards such combinations, and it is therefore easy to conclude that a new era for trade organisations has been opened in that country. For the present and for several years to come there is no probability that the Russian syndicates will be able to play a prominent part in external markets of the kind performed by similar combinations in Germany and the United States. What the Russian organisations may be expected to do—provided, of course, that the Government continues to permit them to exist—is to operate solely in the inland markets, and contend so far as possible with the competition offered by Western Germany and Great Britain. In this respect the Russian works will be largely assisted by the new tariff, which has yet to be enforced, and which is of a more protectionist character than that now in operation, and by the recent Government request made to the local authorities to order plant and equipment for public works as far as possible from native firms. It would not be far from the truth to suggest that Russia is endeavouring to render herself more and more independent of the productions of other countries, and that the official disregard of the formation of syndicates in the iron and steel trades, and the prospect of their extension to the machinery branches, is intended to promote this object as far as possibly lies in the power of the country.

MUNICIPAL TRADING IN ELECTRIC LIGHT.

IF any justification were required for the remarks which we made last week as to the dangers of municipal trading, it is supplied by the report which has come to hand with regard to electric lighting in Dublin. It appears that the Corporation had made an application to the Local Government Board (Ireland) for leave to obtain a loan of a further sum of £48,000 to complete the city electricity system, and to carry out the Clontarf electric lighting scheme. It would appear at first sight that such an application would have been granted without question, but a reference to the facts shows that the position of the Dublin Corporation is similar to that of the St. Marylebone Borough Council, in that there has been a gross under estimate of the cost of this form of municipal trading. It appears that some time ago the Corporation decided to undertake the electric lighting of Dublin. In pursuance of the scheme it was necessary to carry out works at the Pigeon House Fort—a situation well known to anyone who has travelled up the Liffey by steamer. Mr. Hammond's original estimate for the carrying out of the Pigeon House scheme was £254,000. He anticipated that this would produce an annual revenue of £88,500, with a net profit of £21,962. The estimate has now grown to above £300,000, and if the scheme is to be carried out in detail it will cost, according to a leading article in the *Irish Times*, December 10th, over £340,000. No estimate is given of what is likely to be the annual revenue and net profit when the scheme is carried into effect at the cost of £300,000; but it is obvious that the Corporation will have to provide by one means or another, for the payment of interest upon the additional capital outlay of some £90,000. Commenting upon the application for a further advance, the Local Government Board say:—"It would, therefore, appear that £41,500 of the sum of £48,000 now applied for represents an under estimate of the cost of the scheme, notwithstanding the fact that a saving of about £6000 was effected by the adopting of a cheaper mode of generating electricity than that provided for in the original estimate." The letter proceeds:—"To sum up, about 87 per cent. of the additional cost of the work for which this new loan is required appears to be due to expenditnre which does not increase the earning capacity of the system." In explaining how this condition of things came about, the chairman of the Electric Lighting Committee stated that they had trusted entirely to the engineer, and had relied on his estimates. This they were bound to do; it is not to be expected that the aldermen, even those who were selected to serve on the Committee, would be such authorities upon the cost of electrical works that they could gainsay the opinion of an expert. What we do wish to point out is the loss which must inevitably accrue to the ratepayers of Dublin. Had an estimate of £340,000 been presented in the first instance, the Corporation, deeply imbued as they are with the taste for municipal trading, might have hesitated to embark upon the scheme. It now appears that they have irrevocably committed the ratepayers to this policy of purchase, and that there must be a heavy loss. This is often the fate of ratepayers whose representatives hurry them into municipal trading for the alleged relief of the rates. In the hands of a private company, if there had been a loss it would have fallen not upon ratepayers, who are virtually unable to protect themselves, but upon the shareholders to whom the directors would be responsible.

THE L.C.C. AND TRAM RAILS.

IT will be remembered that a somewhat acrimonious discussion has taken place concerning the methods adopted by the London County Council in obtaining tram rails. The Council insist that no work shall be done for them by contractors in this country unless certain conditions regarding wages and hours of work of a very onerous character are satisfied. British manufacturers being thus handicapped, are beaten in price by foreigners, who pay much smaller wages, and carry on their operations without restriction. A section of the Council has revolted against this system, and in the defence of it is being urged that the truth about continental wages is not known. At the meeting of the Council held on December 8th the following resolution was passed:—"That it be referred to the Highways Committee to ascertain and report to the Council (*a*) the number of hours of labour per week worked by the men employed by foreign firms in making rails for Government, provincial corporations, and London tramways and railways; (*b*) the rate of wages per hour paid to such men, and if they do any work on Sundays in connection with the manufacture of such rails; and (*c*) the amount of mining royalties paid by foreign firms as compared with those paid in Great Britain." It appears to us that the information ought to have been in the hands of the Highways Committee long since. Business men, as a rule, know as much as they possibly can of the conditions of the markets in which they deal; and the fact that so responsible a body as the London County Council should now have to go in search of information of the kind goes far to substantiate the argument that the trading operations of the Council are the operations of amateurs. Nor is this all. The Committee are of opinion that an expert should be sent to Belgium to obtain the requisite information, and that a sum of £150 be voted to defray the cost of the expedition. Seeing that there is no secrecy about the matter, and that the information could be obtained from half-a-dozen people on the spot, we can only regard the proposed action of the Council as another evidence of the ignorant fashion in which much of their business is carried on. We are glad to be able to add that the agitation has done good, as the tender of Messrs. Bolckow, Vaughan and Co., Limited, for track rails, amounting to £43,748 9s., has been accepted. The six lowest tenders for the supply of the track rails provide for the use of basic steel, while the specification issued required that the rails to be supplied should be made of acid steel. The chief engineer has advised that as the rails which have hitherto been supplied have been made of basic steel, it was important that, in order that a fair comparison might be made of the relative life of rails made of these two forms of steel, it was desirable that the rails now required should be made of acid steel. The whole of the work will be carried out in England. For slot rails and conductor tees the contract has been placed with the Frodingham Iron and Steel Company. We understand that the tenders are 7 per cent. lower in amount than the Belgian tenders for the same work.

THE INSTITUTION OF MECHANICAL ENGINEERS.

BEFORE commencing the ordinary business of the meeting at the Institution of Mechanical Engineers on Friday evening, the President, Mr. J. Hartley Wicksteed, referred to the great loss which the members had sustained by the death of Sir Frederick Bramwell. He had been a member, he said, of the Institution close upon fifty years, and he contributed a paper to the Institution three years before he joined it as a member. Nearly thirty years ago he was their president. The Institution was his first love, and although since he joined it he had become the valued member of all the principal engineering and scientific societies in London, yet, as the Council knew even better than the members, he never slackened in interest for the welfare of the society, and attended within the last few months both general purposes committees and prolonged Council meetings. He contributed to the Institution a paper in 1851 on "A Vacuum Gauge," in 1867 a paper upon "Floating Docks," and in 1872 on "Modern Engines and Fuel Economy." In 1874 he gave a presidential address, and in 1892 he gave a paper on the "Sewage Outfall Works at Portsmouth," of which he was the engineer, and so lately as 1899 he read a paper on "Atmospheric Railways." He had a great memory and a powerful mind to grapple with large problems, and his brain worked extremely quickly. After hearing the description of complicated machinery he could gather together all the points, arrange them in their due proportion, and epitomise the whole description in a clear-cut memorable form, made picturesque in many cases by some unexpected analogy. During the thirty years that had elapsed since his presidency, the presidents who succeeded him, one and all, felt that while they commanded the ship they had a pilot by their side so long as Sir Frederick Bramwell was with them. Concluding, Mr. Wicksteed read a letter of condolence which he had in the name of the Council addressed to Lady Bramwell. The meeting received the speech standing and in silence.

The ordinary business included the reading of a list of names of something over one hundred new members and the presentation and discussion of a paper by Mr. Stromeyer and Mr. Baron on the Softening of Water. We commence to reprint this paper on page 627. It is in many respects a valuable contribution, and the collection of the various types of softeners will be found convenient for reference.

The discussion was well sustained, but it did not add much to the information given by the paper. Many of the speakers took exception to the author's remarks about the small effect that incrustation had on economy, and no doubt many felt relieved by Mr. Maw's explanation that what was probably meant was that the amount of incrustation that collected in the intervals between the periodical cleaning out of the boilers was not of great consequence from the point of view of fuel consumption. The great objection to incrustation was the wear and tear that it entailed. An interesting question was raised by Mr. Michael Longridge and the President. They asked if pressure assisted in causing the deposition of a precipitate in the settling tanks. In some purifiers the liquid is pumped through under a pressure of about 60 lb., and it is claimed that precipitation is thereby hastened and that the pressure takes the place of heat. Mr. Hatch replied, but apparently he had not fully understood the question, as his remarks were mainly directed to the condemnation of filtration under pressure. The same speaker asked if the figures reported in the paper were the result of surprise visits or if they represented the very best that the apparatuses could do. If the latter, he thought the results were disappointing. He dwelt also upon the necessity for simplicity; condemned inclined plates as recipients for deposit, and touched upon the difficulty of removing carbonate of lime by filtration.

Mr. Brown, of Siemens, had a novel advertisement for Mr. Halpin. They had found that one of his storage vessels was excellent as a purifier, bringing down the carbonate—about one ton of it in seven weeks. They used to have to clean out their boilers once every seven weeks; now once every twenty-one weeks is found sufficiently often. Mr. Stevens, who is interested in one of the purifiers illustrated, defended complication in general by the broad statement that simple purifiers were, as a rule, inefficient. It was necessary that the chemicals should be measured out exactly, and this necessarily involved some extra parts. He explained by figures that where a purifier costing £600 or so was used by a railway company in the London district, it paid for itself in one year by the saving in fuel—evidently he does not agree with the authors—and labour which is usually spent on cleaning and tinkering with the boilers. Another speaker defended the heat treatment, affirming, we think correctly, that too much had been made of the expense entailed, as the greater part of the heat given to the water was in a well-designed system carried over to the boiler.

Mr. Archbutt, who, as everyone knows, is deeply interested in a particular system, was very sore because the author had gone round and collected information without telling him. If he had been given opportunities for providing the information himself, or for seeing that the plants inspected were working at their best, there would have been better results to record. Mr. Tebutt was the next speaker; he spoke in warm terms of the Archbutt-Deeley purifier, which he admired particularly for its simplicity, but he ingenuously remarked that the chemists who asserted that they knew all about the chemical reactions in softening were still in the dark; at any rate, they had been entirely wrong with regard to the water he used. He gave up the use of pearlash, and took to caustic soda, with the result that his precipitate came down much more quickly.

Mr. S. Terry did not agree with Mr. Stromeyer about the slight effect scale had on efficiency, but he strongly commended that thin scale which all engineers know and respect. There were a few other speakers, and both Mr. Baron and Mr. Stromeyer replied quite shortly.

Mr. Wicksteed was excellent in the chair; he must certainly at some time or another have presided at a debating society. He kept what might easily have been a prolonged and tedious debate within reasonable limits, and his firmness with speakers who exceeded the five-minute allowance was a thing to see and emulate.

LONDON, BRIGHTON, AND SOUTH COAST RAILWAY IMPROVEMENTS.

No. V.

THE widening works between East Croydon and Balham, two of the suburban stations of the London, Brighton, and South Coast Railway, have been recently completed. They constitute another link in the great undertaking which the directors of the company have set themselves to accomplish in the interests of the public. On the accompanying diagram plan are marked the positions of the different features of the route, to which reference will be made. It should be mentioned that each line represents a track or pair of rails, and that the object in this particular instance was to lay a couple of new local tracks instead of running the traffic over the old lines. It will be seen that all the four stations are laid out on the same plan, and are built with a central island platform and two side platforms, defined by the letters C, S_1, and S_2. All down lines are indicated by arrows pointing from left to right, and all up lines by those pointing in the opposite direction. The local lines pass between the central platform C and the side platform S_1, and the main lines between platforms C and S_2.

The Croydon and Balham widening may be considered to commence at a short distance from Streatham Common Station, at about the line A A marked on the diagram plan, near which is situated old Mitcham-lane bridge. It is close here where a pair of local and a pair of main spur tracks take off to join the Peckham and Sutton line, which, a little further down, bifurcates in the direction of Tooting and Sutton. The local tracks are carried by a curved brick arched viaduct upon a rising gradient to an overbridge crossing the widened four-track way. A view of the crossing, and an elevation of part of the viaduct, are represented in the engraving, Fig. 1, page 619. This piece of extra work was undertaken in accordance with what may be termed a standing order of the company, universally adhered to where practicable—the avoidance of tracks crossing others on the level. The construction of the flying junction, in the plan, for the local lines obviates all necessity of their running over the main lines to effect their connection with the new route. With the main spur tracks there is no difficulty, as it will be seen there are no other lines which they have to cross. At certain distances along the elevation of the viaduct there are projections corbelled over from the face of the brickwork. These are small recesses, intended as refuges for the protection of men working on the line from passing trains. The span of the arches is 18ft. 10½in., the rise 4ft. 6in., thickness 1ft. 6in., and they are struck from a radius of 12ft. 1½in. In other respects, the brickwork is of a similar class to that already described for the viaducts in the previous articles quoted. It should be mentioned that all exposed surfaces are faced with brindle bricks. Between the flying junction and the Streatham Common Station are situated the Southwark and Vauxhall Waterworks. Some of their outbuildings were taken by the railway company to make room for an additional track on the local Portsmouth lines.

The Streatham overline bridge carries the pair of locals over the widened tracks. The steel girders of this structure are of the same type, similar in profile, design, construction, and in general dimensions to the example on the London, Brighton, and South Coast Railway widening to Pouparts Junction, which spans the London and South-Western line. There are one or two points of difference which may be mentioned, bearing in mind that we are referring to only the superstructure of the bridges. The overline bridge is a pony truss, and is, therefore, not provided with the usual overhead arched open-web bracing common to deeper trusses. Cross girders and rail-bearers are used in the platforms of both bridges, but instead of steel flooring plates, troughing is employed. One of the main trusses measures 134ft. and the other 140ft. in span, and the upper booms are curved to a radius of 352ft. A temporary bridge was built upon trestles at the site, and the trusses were riveted up complete a few feet above their bearings. In addition to the main trusses there is a smaller side span at the Streatham Common end of the bridge. It consists of wrought iron plate girders 50ft. in length, and the up main track passes underneath. The whole bridge is very considerably on the skew. On the south side of Streatham Common Station a bridge is carried over Greyhound-lane, with a span of 27ft. on the square and a built-up trough flooring, which was rendered necessary by the fact that the gradients could not be altered, and therefore the headway was obliged to be cut very fine. Here the wing-walls were so constructed that they acted as retaining walls for some distance at right angles to the face of the abutments. Further along the line is Hermitage Green bridge. It has a span on the square of 40ft. and of 52ft. on the skew, and its construction is similar to that of the last mentioned. In both these instances the old bridges were demolished.

A reference to the diagram plan will indicate that a few yards southwards of the flying junction bridge the four tracks are crossed by the Peckham and Sutton line bridge. This was converted, to suit the requirements of the widening in the following manner. The existing abutment on the Sutton side was partially removed, and partially rebuilt in the form of a pier. A new abutment was then added, and the necessary extra short span obtained. At Streatham Junction South Box the flying local lines and the two main spur tracks run on to the Peckham and Sutton branch. The London-road, close to Norbury Station, is crossed by a bridge, of which there is more than one example on the present widening.

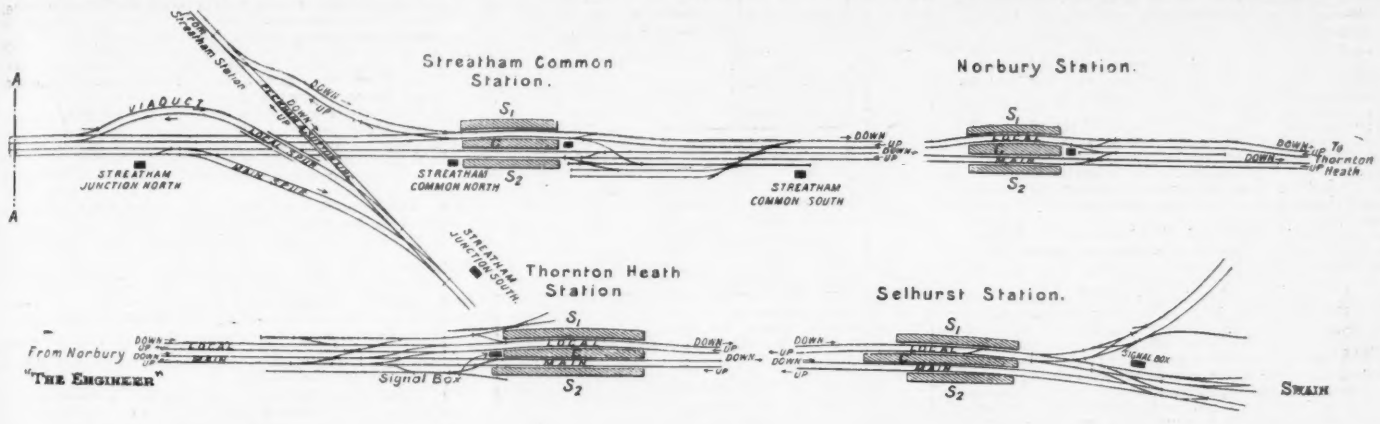
The next station, that at Thornton Heath, has been selected as the site for a very considerable goods and coal depôt. The surface of the yard is ballasted with chalk, obtained from the company's quarries at Purley. It should be stated the batter of all retaining walls, wing-walls of bridges, and similar buildings is 1 in 8, and that the concrete, which forms an important part of many of them, especially of the backing, consists of Thames ballast and Portland cement, mixed in the proportions of 7 to 1.

The Thornton Heath Station buildings and booking offices are carried upon the Brig Bridge, as it is locally termed, which takes the main road, which has been widened, and a double tramway track over the railway. In this instance the centre part of the old bridge, which consisted of cast iron girders and built-up wrought iron troughing, was retained, and the widening executed on both sides. The soffit of the whole structure was covered with expanded metal and concrete to preserve the ironwork underneath the road. All cables, wires, pipes, and drains are laid in the furrows of the wrought iron troughing. On the north side of the Thornton Heath Station is the Beulah Bridge, represented in the engraving, Fig. 2, page 619. A double row of cast iron columns divides the distance between the east abutment and the opposite pier into three spans. Plate girders and the employment of troughing enabled the requirements of the headway to be satisfied, which was of very limited dimensions. All the new lines are laid with steel bull-headed rails, weighing 96 lb. to the yard run, upon cast iron chairs, fastened to the sleepers by a couple of wooden trenails and a pair of iron spikes, one of each kind being driven on each side of the rail. In all instances in which built-up wrought iron troughing was employed for the flooring of bridges in the open the same care was taken to protect the metallic soffit as when the structures were close to a station and exposed to the noxious fumes from the engines.

The four new stations are all built after the same general design, with slight variations to suit the requirements of the traffic, and the local conditions, which are never precisely the same at any two stations. A width of 40ft. is given to all the central or island platforms, and 20ft. to each of the other two. All the platforms are, or will be, laid with Stewart's granolithic stone, with a bottom layer 2in. in thickness. The broad coping is of the same material, and consists of slabs 4ft. in length by 3ft. wide, and of a thickness of 4in., set in cement and roughened all along the edge. In the engraving—Fig. 3, page 619—is shown an elevation of one of the stations, which have a very neat appearance, irrespective of the other improvements over their old timber predecessors. The engraving represents Thornton Heath station, which may be taken as being typical of all the four new buildings. The general entrance halls, in which are the booking offices, and a sufficient amount of accommodation to constitute, in addition, waiting rooms, vary slightly in size. At Streatham Common and Selhurst stations the dimensions are 35ft. by 30ft., and at Thornton Heath 40ft. by 30ft. Blue Staffordshire bricks are used for the plinths of the buildings, and red bricks from Keymer for the facework. At the back, extending over the whole width of the line, is a covered corridor or verandah, from which three staircases lead down to the three platforms.

Just south of Selhurst Station the railway is carried over the Selhurst public road by a couple of bridges, one for the local and another for the main lines. The new structure is built similarly to the older example of plate girders and trough flooring. They are both on a sharp skew, perfectly independent of each other, and are separated by an open space about 6ft. in width. This opening was left at the instance of the local authorities. A similar course was pursued in the case of the new bridges erected over the main roads crossed by the tracks laid in connection with the extension of the Clapham Junction Station by the London and South-Western Railway.* Gloucester-road Bridge, situated also to the south of Selhurst, is a completely new erection, carrying the main lines to Brighton, and crossing the new local lines to Croydon. It is of the plate girder type already described. In the same direction the York Bridge is met with, which is of rather a peculiar construction, so far as the appearance is regarded, which was necessitated by the exceedingly awkward skew of the bridge. To the same cause is due the heavy retaining wall, which acts as an exceptionally long wing-wall. The trough flooring is stiffened by rolled joists. The bridge carries the down local from London Bridge to Victoria, and crosses the up local from Croydon to London Bridge. At Croydon a fifth track has been laid to accommodate the Tunbridge Wells traffic. A good deal of the work had to be carried out at night time, which is another reason, in addition to those already stated, for the comparatively high cost of engineering operations of the character forming the subject of our article.

Our thanks are due to Mr. Charles Langbridge Morgan, M. Inst. C.E., engineer-in-chief to the London, Brighton and South Coast Railway, for permission to go over the widening, and to Mr. A. Gordon Robertson for accompanying us, and for the photographs he has placed at our disposal. The Horseley Company was the contractor for all the steel and ironwork, and Messrs. John Mowlem and Co. for the other portions of the work. The permanent way was laid by the company.



50-TON HYDRO-ELECTRIC OVERHEAD CRANE

THE new engine erecting shop at Swindon is equipped with four overhead cranes, built at the works, and designed to be operated by electricity, and yet retain the advantages of the direct hydraulic lift for heavy loads.

Each crane consists of two main girders carried by a pair of wheels at each end, and connected by a knuckle joint to ensure an equal distribution of the load on the wheels. A motor for traversing the crane is mounted at the centre of one of these girders. The two lifting carriages supported by the main girders are self-contained and independent. Each carriage is carried on four wheels, with the hydraulic cylinder mounted on a ball-and-socket joint in the centre, the pressure being obtained from a set of quadruple hydraulic pumps fixed at one end of the carriage, and driven by an electric motor. At the opposite side to the pumps is placed another motor which operates the barrel for lifting light loads by means of a wire rope, a third motor being provided for traversing the carriage.

A load of 25 tons may be lifted by each of the hydraulic cylinders. The pump motor having been started, the operation is controlled by a lever in the driver's cage, which is connected to a balanced valve, the water being allowed to enter the cylinders or circulate past it into the tank at will. An auxiliary valve is connected to the same lever, which permits of a fine adjustment in lowering. Small articles up to 2½ tons may be dealt with by the light lift, which is controlled by a water switch, the motor for same being fitted with a magnetic brake.

The electric current is supplied to the crane at a pressure of 250 volts by means of sliding contacts, the speeds attained being, travelling up to 300ft. per minute, cross travelling up to 120ft. per minute, heavy lifting up to 5ft. per minute, and light lifting up to 30ft. per minute. Through the courtesy of Mr. G. J. Churchward we are enabled to illustrate this ingenious crane by drawings which appear as a supplement to the present issue.

BOOKS RECEIVED.

The Strand Magazine Christmas Number. George Newnes, Limited, London.

The Motor Car Acts, 1896-1903. The *Autocar*, London, E.C. Price 6d. net.

Kalender für Seemaschinisten, 1904. Von E. Ludwig und E. Linder. München und Berlin: R. Oldenbourg. 1904. 6 marks.

The Story of the Atlantic Cable. By Charles Bright, F.R.S.E., A.M. Inst. C.E., M.I.E.E. London: George Newnes, Limited. Price 1s.

Technical Mechanics. By Elward R. Maurer. New York: John Wiley and Sons. London: Chapman and Hall, Limited. Cloth, 17s. net.

Irrigation Engineering. By Herbert M. Wilson, C.E. New York: John Wiley and Sons. London: Chapman and Hall, Limited. Cloth, 17s. net.

Fowler's Electrical Engineers' Year-book and Directory of Light, Power, and Traction Stations. 1904. Price 1s. 6d. net. Scientific Publishing Company, Manchester.

"Knowledge" Diary and Scientific Hand-book for 1904, *containing Original Descriptive Articles on the Camera applied to Science.* London: *Knowledge* Office. Price 3s. net.

The University Tutorial Series: The Tutorial Statics. By William Briggs, LL.D., M.A., and G. H. Bryan, Sc.D., M.A. London: W. B. Clive, University Tutorial Press, Limited.

The University Tutorial Series: The Tutorial Dynamics. By William Briggs, LL.D., M.A., and G. H. Bryan, Sc.D., M.A. London: W. B. Clive, University Tutorial Press, Limited.

Every Man's Own Lawyer: A Handy Book of the Principles of Law and Equity. Comprising the Rights and Wrongs of Individuals. By a Barrister. London: Crosby Lockwood and Son. Price 6s. 8d.

The Localisation of Faults in Electric Light and Power Mains, with Chapters on Insulation Testing. By F. Charles Raphael. Second edition, revised. London: The *Electrician* Printing and Publishing Company. Price 7s. 6d. net.

CRYSTAL PALACE ENGINEERING SCHOOL.—The "Wilson Premium" for the best paper read before the Crystal Palace Engineering Society during the present session has been awarded by the Council to C. G. Everington for his paper on "Gold Mining Machinery." Other papers read during the session were "Mining," by C. E. Fradgley; "Historical Locomotives in the South Kensington Museum," by A. Maude; "Tubes and Subaqueous Tunnelling," by D. W. Murray, and "The Abatement of the Smoke Nuisance," by T. O. Pepper. The "Premium" was presented to Mr. Everington by Sir. E. H. Carbutt, past-president of the Institution of Mechanical Engineers, on the occasion of the ninety-third distribution of certificates at the above school on December 17th, 1903.

* No. IV. appeared August 14th.

* THE ENGINEER, May 1st, 1903.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

BREAKDOWNS IN THE NAVY.

SIR,—Your able correspondent Mr. Jane has adopted a well-known but on the whole ineffective system of controversy. He has set up men of straw and then knocked them down. His letter is interesting; but it has very little to do with the statements I have made. Thus, he appears to think that breakdowns may readily be explained by the conditions of keeping station, the speeds being altered so often; but this kind of thing is not peculiar to the Navy, as Mr. Jane would soon find out if he spent a couple of hours in a big cargo steamer working up a crowded river into dock. I have known the speed altered about forty times in half an hour. The engine-room gong is with some pilots never quiet. You have hardly got full speed ahead till you have full speed astern. All this kind of thing, whether in the Navy or mercantile marine, is trying to the temper of those on watch in the engine-room, but it does not mean breakdowns. There is, I can assure Mr. Jane, nothing in it.

If Mr. Jane chances to be the spokesman of any large number of naval engineers I am very sorry, because he demonstrates in that case that these gentlemen have quite failed to grasp the significance of the facts. I say that it is a very terrible matter that no less than twelve big fighting ships should be disabled in a week. Such a thing occurring in actual warfare would be a national calamity of the gravest kind. To talk about the orders from the bridge having anything to do with this is simply absurd. If Mr. Jane really is able and willing to thrash the whole question out, he will do right good service; but let us discuss it not on a basis of opinion but of fact. I do not think that your correspondent realises at all the nature of the defects which occurred. Take, for example, the Powerful. I have not the precise figures, nor does it matter. Let us say that 30,000 indicated horse-power give her 23 knots. Then at half that speed she would not require more than about 5000 indicated horse-power—that is to say, this splendid ship, a few hours after she begins to take part in mimic warfare, is reduced to one-sixth of her power, and so continues to the end. May I ask why? How was it that the crank pits got full of water? My explanation is that she ran her crank shaft and big ends hot. The water service was brought into play, and the bilge pump strums being neglected, and therefore choked, the water accumulated. From first to last this was all wrong. It is very far indeed from my purpose to blame any individual, but the nation will not shut its eyes to facts. These things do not occur in big Atlantic liners. They are quite preventable. They ought to be prevented in the Navy. An explanation of precisely how the Powerful came to be disabled will be of the utmost possible value, and I trust that as Mr. Jane seems to be in a position to supply it he will let us have it.

But the case is not isolated. We hear that a cylinder cover joint blew, and, in consequence, a ship was disabled for many hours. The only cover joint that could blow is the one at the top of the cylinder, and is quite accessible. It is one of several broken and made again every time the engines are opened up. I do not know whether the joints in the Navy are made with wire gauze or asbestos paper. I take it that they are not metal to metal; but, in any case, the joints ought to have been re-made in little more than the time required to get the stud nuts off and on again. Indeed, three or four artificers ought to do the whole job in about half an hour. It appears, however, from the reports that no one on board could do it at all, and the ship had to seek extraneous aid.

It is not necessary to take up more space by citing other examples of breakdowns. If Mr. Jane says that he cannot get at the precise facts in the cases I have named, then I would ask him to pick any one of the dozen available, I am sorry to say, and give his explanation; but it seems to me that he can only excuse those in charge of the machinery by finding fault with that machinery. I am quite well aware of all the cramping of which he speaks; I have not passed through life without making myself acquainted with the engine and boiler-rooms of the Royal Navy, and I am happy to say that among my old friends I can name many who have served their country well, and some who are serving it still in our fleets. I am not writing without knowledge, and I repeat, and repeat with sorrow, that a grave mistake will be committed if the ghastly failures of the last manœuvres are permitted to pass into oblivion without rigid investigation.

Mr. Jane says that the engineers of the Royal Navy have nothing to learn from the engineers of the mercantile marine. Let me bring one telling fact home to Mr. Jane. There is hardly an engineer in the German mercantile marine who has not served in the German navy, and, on the other hand, there is a large body of men in such ships as the Deutschland and other great liners who are liable to serve again in the navy at a moment's notice, and who will bring to that service a vast experience acquired in a different school. The engineer cannot push his experience too far, and I maintain still—*pace* Mr. Jane—that all naval students should at some part of their course acquire experience in the mercantile marine, and see how things are done there. I can assure all interested that it would open their eyes. There is far too great a tendency to say, "Oh! my engines are quite different from yours." There are certain highly important points which are the same in all engines. There are running now in the Channel service boats of 5000 or 6000 indicated horse-power, at 160 to 180 revolutions per minute, and with short connecting-rods, and much cramped. The worse the design of the engines the more necessary it is that those in charge should know every dodge and device for keeping them going. When I read that after a few hours' running one crank pit is drowned with water; that in another ship the very brasses are melted out and the crank pins ruined by scoring; that a high-pressure cylinder cover cannot be jointed without help, and so on, I can draw but one conclusion, which is that explanations are wanted, and that Mr. Jane has not even grasped the magnitude of the evil about which he writes with so free a pen.

I can only repeat that if he will tell us, your readers, precisely why that happened which beyond question did happen he will do his country a better service than he can perhaps realise.

I know quite well that the pens of officers in the service must remain dry, but I have yet to learn that they are wholly unable to make facts public. It is quite clear, at all events, that Mr. Jane is inspired. Is it too much to hope that his inspiration will enable him to tell us why, for example, the crank pit of the Powerful became flooded?

SUPERINTENDING ENGINEER.

Liverpool, December 21st.

THE STEAM TURBINE FOR STEAMSHIPS.

SIR,—I have no knowledge of what the actual steam consumption of the steam turbine is when used as a marine engine, nor do I know exactly its economy for other purposes. I have seen no evidence that its economy is superior to that of our best land engines. It may be that for marine purposes it has proved itself nearly, if not quite, equal in economy to that of the average marine engine. Its simplicity and few moving and wearing parts are of great importance. Whatever its economy may be, it is necessary to take seriously into consideration the consumption of fuel on board ship, and for that purpose a combination of a reciprocating engine and steam turbines promises to give a greater economy than can be obtained from turbines alone; for reasons which will be explained after giving an outline to the scheme.

The combination proposed is indicated in Fig. 1. It will be seen that there are three screw shafts. The centre one is worked by means of a reciprocating engine taking steam at, say, 200 lb. pressure, and discharging it at, say, 50 lb. pressure, for working the two wing screw shafts by means of low-pressure turbines. The combination divides the power equally between the three shafts. The reciprocating engine would be a very simple one, of the compound type, with cranks at right angles, having a cylinder capacity of only one-fifth of that required if reciprocating engines alone were used. We then have a small compound reciprocating engine and two low-pressure turbines in the place of five turbines, as at present used—three for going ahead, and two astern.

Economy of fuel.—Assuming that turbines equal in economy the best reciprocating engines, where would the economy of the above scheme come in?

The steam turbine has two parts, high and low pressure, and it is readily seen that it has in principle an advantage over the reciprocating engine in having none of its parts alternately exposed to a high and low temperature, like that of a steam cylinder. That is common to the two parts. The low-pressure part has also an advantage in principle in being capable of expanding the steam to the condenser pressure, instead of to the terminal pressure of the cylinder—say, 10 lb. above it. It has in both parts, however, a disadvantage in having more leakage. The advantage of more complete expansion makes it appear that the low-pressure part of the turbine is the more economical of the two. Reciprocating engines have also a high and a low-pressure part, and the high-pressure part gives the higher efficiency ratio. It follows, then, that a combination of the high-pressure part of the reciprocating engine with the low-pressure part of the turbine would give increased economy, especially when leakage is also taken into account. If we refer to Fig. 2, it will be seen that the reciprocating engine would develop the power represented by the area X, and the two turbines that represented by Y. If reciprocating engines alone were used, the expansion would stop at G, but with turbines it can be carried to H—or, in other words,

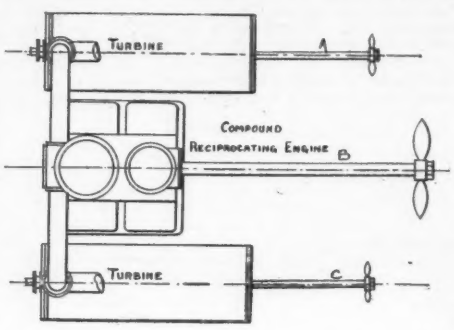


FIG. 1.

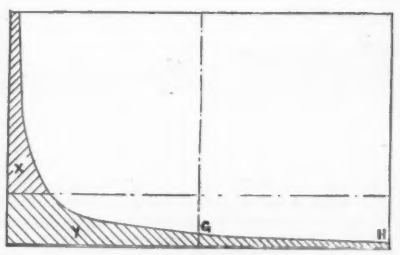


FIG. 2.

doubled. There is, then, every reason to suppose that the scheme would secure economy of fuel.

We now come to its practical application and mode of working. The reciprocating engine would be provided with the ordinary reversing gear, and attached to the reversing gear would be mechanism operating valves for causing it to discharge into the turbines or direct to the condenser.

Full or reduced speed ahead.—Engine discharging into turbines.

Stop.—Reversing lever to mid position, stopping engine and turbines.

Reverse.—Reversing lever put over, turbines idle, engine reversed. The engine now exhausting into the condensers direct. More than one-third full power is thus available for going astern.

Easy ahead or going astern.—Turbines remain idle, and ship is under command of the engine by means of the reversing gear.

Manœuvring.—Referring to Fig. 1, one of the wing shafts, A or C, might be going ahead and the other shafts idle, or one of the wing shafts might be going ahead and the centre shaft going astern.

HENRY DAVEY.

3, Princes-street, Westminster, December 17th.

TURBINES.

SIR,—I note "F. I. D.'s" letter in your issue for D.c. 11th and your Reviewer's reply. If the best relative velocity of the buckets of an impact wheel be one-half that of the water or steam, then the maximum efficiency cannot exceed 75 per cent., the whole energy in the jet being taken as unity.

To make this clear, let the velocity of impact be 100ft. per second and that of the buckets 50ft. per second. Then the maximum reduction that can take place in the velocity of the water is 50ft. per second. This does not require proof, it is obvious.

Now the kinetic energy varies as the square of the velocity. The square of 100 is 10,000. That of 50 is 2500, and 10,000 – 2500 = 7500.—*Q.E.D.*

It follows that if efficiencies of 80 and 85 per cent. are obtained, as sometimes claimed, the velocity of the buckets cannot be half that of the jet, but some higher velocity. Perhaps some of your readers will say what it is. If such efficiencies are obtained, then the proposition I have quoted above must be wrong.

HELIX.

December 21st

SUBAQUEOUS TUNNELS.

SIR,—For the construction of the east half of the river portion of the Harlem River Tunnel in this city for the Rapid Transit Railroad I am prepared to say that the method I have adopted therefor, and am now carrying out, will be a great improvement on the novel method under which I successfully constructed the west half of the river portion of this tunnel.

Briefly stated, the first method was to dredge a channel across the river bottom to within a few feet of the full depth of excavation required for to build the tunnel. In this channel foundation piles and a row of specially prepared heavy timber sheeting, along each side and across the ends, were driven and cut off to a true plane about 25ft. below the surface of the water. This sheeting forms the sides and ends of a pneumatic working chamber.

For the roof of this chamber a platform of timber 40in. in thickness, and extending the full width and length of the tunnel section, was built and sunk, and rested on the cut-off sheeting which formed the sides and ends as above described.

Simultaneously with pumping the water from under this roof compressed air was forced into the chamber under a pressure corresponding to the pressure of the water above the roof. Inside this chamber the west half of the tunnel was built, and then the timber roof was removed.

The new method for the east half of the river, briefly stated, will be to prepare the sides of the pneumatic working chamber as above described, but the sheeting and piles will be cut off about 12ft. lower down than was done in the former case, or exactly on the grade of the spring line of the arch of the tunnel.

The top half of the tunnel will be built at the surface on pontoons, then launched and floated over the tunnel site, and sunk into its final and true position, the outward flanges of it resting on the cut-off sheeting above described. Then the top half of the tunnel will be used to form the roof of the pneumatic working chamber.

In this chamber the foundation and bottom half of the tunnel will be constructed with the use of compressed air, thus dispensing with the timber roof as used in the first method, and greatly decreasing the cost of the construction of the tunnel in many ways.

This method is bringing the construction of subaqueous tunnels to a fine point.

This method provides for preparing a foundation where the material under the bed of the river is not sufficient in itself. The sheeting which forms the sides of the working chamber is driven deep enough to penetrate and confine the earth material under the tunnel for several feet below sub-grade. The foundation piles driven in this confined material compacts it.

This method enables a tunnel to be constructed under a navigable river, with the minimum depth of water over it that the U.S. Government requires for navigation.

For illustration, take the tunnel now being constructed across the East River from Battery-place, Manhattan, to Joralemon-street, Brooklyn. By this method that tunnel may be raised 35ft. higher than it is now located and still be below the U.S. Government dredging line; by thus raising it there would be 3000ft. of 3·1 per cent. of the grade eliminated.

With regard to safety and surety, this method is to subaqueous tunnel work what prominent caisson work is to deep excavation work, viz., absolutely safe and sure.

By this method the pneumatic working chamber is built in place immediately encompassing the work to be done; the pressure of the water on the outside of it is counterbalanced by the pressure of compressed air forced within it, consequently it is not subject to the heavy ordeal that a working chamber under a pneumatic caisson sunk from surface would have to undergo, therefore is much cheaper to construct.

This method enables the construction of a tunnel any desired shape or dimension. Tunnels where two or more railroad tracks are required may be built under the one roof and with partitions and intercommunicating openings where desired, whereas with the shield process they are limited to single track tunnels and a circular form.

A double-track tunnel can be built under this method at much less cost than twice the cost of a single-track tunnel, a four-track tunnel at much less than twice the cost of a double-track tunnel.

This method enables the construction of tunnels with light grades in the sand across such rivers as the Ohio, Missouri, and Mississippi, and provides against their being undermined. A modification of this method is provided for cases where the river bottom is rock, to bring the roof of the tunnel to the top of the rock if required.

By this method roadway tunnels with light grades for teams and foot passengers may be built across the Harlem River at a much less cost than bridges.

This method enables the construction of a tunnel with a light grade across the Detroit River at Detroit, and avoids the difficulties that were encountered in the original attempt to build a tunnel at that place.

The use of compressed air in driving a tunnel horizontally with a shield is dangerous; a pressure of air sufficient to keep the water from running in at the bottom of the tunnel is liable to blow out at the face at the top of the shield, whereas with this method there is not any such danger.

The cost of a subaqueous tunnel built by this method as compared to a tunnel in our streets, the excavation for the tunnel in the river can be dredged out, consequently done much cheaper per cubic yard; less timber is required because the air pressure within the working chamber offsets the pressure from without. The advantage of building the top half of the tunnel in the open air at the river, as proposed above, over that of having to haul all the material to the street and place it, as must be done for a land tunnel, is obvious. The building of the lower half of the tunnel is somewhat in favour of the land section, but not to any great extent.

D. D. MCBEAN.

New York, December 10th.

RECIPROCATING MACHINE TOOLS.

SIR,—In the Supplement on "Reciprocating Machine Tools," published in THE ENGINEER of December 11th last, particulars of a series of records taken under Captain Tresidder's directions at Messrs. John Brown and Co.'s works are largely reproduced and quoted from.

These records date back nearly four years. At that time the electrical driving of heavy machine tools was in an experimental stage, and it is perhaps well to point out that the system of driving originally adopted at the works in question has since, as the result of experience, been considerably modified.

In the original installation each armour plate planing machine had a separate 20 horse-power motor, but it was found that this was liable to be overtaxed when the machine was running on a short stroke and reversing frequently. Later, three of the same machines were experimentally driven by one 40 horse-power motor, which did the work easily, though 60 horse-power, applied independently by three 20 horse-power motors, had not been enough. Large motors, running groups of planers, were then generally adopted, and were rarely found to be overloaded, while the average load was much closer to the motor's rated capacity, thus conducing to greater economy of operation and upkeep.

In discussing the question of the reversal of high-speed planing machines, in the article referred to, no mention is made of the magnetic clutch drive, which seems to be the best solution of the problem yet introduced, and has been perfected at John Brown and Co.'s works after prolonged experiments.

The current through the clutch coils can be regulated to cause any desired amount of slip at reversing, and the wear due to such slip is taken on flat steel rings on the clutch faces, which can be cheaply renewed, though in practice this wear is found to be slight. The belts and pulleys—or gearing, as the case may be—are always running in the same direction, and consequently in screw-driven planers, the fly-wheel effect so prejudicial to quick reversal is simply that due to the small bevel wheels on the driving screws, as the large and heavy belt carrying pulleys are not reversed at all. Further, as the belts are not shifted to and fro on the loose pulleys, they last very much longer. In the case of a large machine the consequent annual saving in cost of belts is quite substantial.

The remarks made on the question of many *versus* few tools take no account of the change effected in methods of working by the new high-speed tool steels, and for the same reason the feeds and speeds used in the experiments referred to no longer represent current practice.

With existing machines, at any rate, two-round nose-surfacing tools, while taking as heavy a cut, will punish the machine far less than a number of tools dividing the same cut between them. The limiting conditions of feed and speed now lie in the machines themselves, and not, as hitherto, in the tool steel.

As regards double-cutting, the problem is only half solved. Some arrangements work well for traversing cuts; but in deep parting cuts with cranked tools there is interference between the

tools, and a difficulty occurs in dividing the cut between them, unless they are placed an impracticable distance apart. It is difficult to adapt double-cutting arrangements to existing planers satisfactorily, because of the shake and chatter caused when all the joints of the swivel, saddle, and cross-slide are in tension. For such work all gibbed joints should be of square instead of V section.

MAURICE E. UNWIN.

Atlas Works, Sheffield, December 21st.

INDEFINITE SCIENCE.

SIR,—It so happens that the school in which I was taught—largely self-taught—science, attached very great importance to accuracy of definition. We soon discovered that there was no real progress to be made unless we understood what we were talking about. I well remember one man, an American withal, who always insisted on our explaining precisely what we meant, and I have never forgotten his ridicule when we were vague, or the verbal traps into which he led us when we were not precise.

Now, I have read the two reviews of two important works, one by Professor Reynolds and the other by Professor Thomson, which have recently appeared in your pages, and I wish now to point out that physical science seems to me to be rapidly deteriorating and falling into mere vague speculation, resting on a most insecure basis of mathematics; the true road of science is left, and quagmires are taking its place.

It would occupy far more space than I dare ask for if I went into this matter in detail. I shall confine myself to one thing, and one only. I do not ask any leader of science to tell us what electricity is; but I do think that we ought to have an explanation of the sense in which the word is used. It is at least certain that electricity to the practical electrician is not the electricity of which Sir Oliver Lodge speaks when he is in the clouds, nor is it the electricity of Thomson or Marconi.

To give a direct example of what I mean, Sir Oliver Lodge says that electricity is probably the cause of inertia. What does this mean? So far as I am aware, Sir Oliver Lodge has given no hint of the nature of the mental concept he has formed. I confess I have no idea what the words mean, nor have I met with anyone who has.

Inertia is nothing more than a phase of Newton's first law of motion: "Every body perseveres in its state of rest or of moving uniformly in a straight line, except in so far as it is made to change that state by external forces."

Now, so far as I know, electricity is supposed to be a mode of motion analogous to heat. I have a 50-ton fly-wheel revolving at twenty revolutions per minute. It possesses inertia—reluctance to go any faster—and momentum—reluctance to go any slower. In a word, it is endowed with persistence. I do hope your readers will not pin me down to an exact definition of condition.

Will Sir Oliver Lodge or someone who understands him tell me just how electricity controls the mass of my fly-wheel? How does electricity make it turn the crank over the dead centre? How does it keep the engine from running away when the piston is at half stroke?

I cannot for a moment bring myself to believe that Sir Oliver Lodge uses words without a definite meaning. I am certain that if he will explain the precise relation which he believes exists between electricity and my fly-wheel he will confer a boon on everyone who, like myself, is trying to keep pace with the leaders of scientific thought.

P. A. B.

December 21st.

FOREIGN TRAMWAY RAILS.

SIR,—In the article *re* English *v.* foreign-made tramway rails, in your issue of 11th inst., it is stated that "so far as the writer is aware, foreign manufacturers have not yet secured tram-rail orders from any of our inland towns." Now, I happen to possess information not perhaps made so public as it ought to be, and I can name the following "inland" electric tramway systems—among others—in which foreign-made tram rails have been, or are being wholly or largely, employed.

Municipal.—Ashton-under-Lyne, Bexley, Birmingham, Derby, Doncaster, Ilford, Ilkeston, Oldham.

British electric traction companies.—Birmingham and District, Dudley and Stourbridge, Dudley and District, Dudley and Wolverhampton, Kidderminster and Stourport, Middleton, North Staffordshire, Oldham, Ashton, and Hyde, Potteries, South Staffordshire, Yorkshire Woollen District.

Other companies.—Carlisle, Cheltenham, Coventry, Norwich, Wakefield and District, &c.

Among other than "inland" tramway systems the following, I believe, have been or are being wholly or largely constructed with foreign-made tram rails:—

Municipal.—Aberdeen, Ayr, Bournemouth, Cardiff, Dover, Dundee, Great Crosby, Hull, L.C.C., Lowestoft, Newcastle, Newport, Portsmouth, Southend, Southport, Sunderland, Yarmouth.

British electric traction companies.—Barrow-in-Furness, Devonport, Gateshead, Gravesend, Greenock, Hartlepool, Poole and District, Rothesay, Southport and Birkdale, Swansea, Tynemouth.

Other companies.—Camborne, Cork, Dublin, Grimsby, Isle of Thanet.

In a few other instances—as at Leeds, Rochdale, Salford, Halifax, Glasgow, Liverpool, Blackburn, Darwen, &c.—orders have been given for small tonnages of foreign-made rails, but the experience gained has generally led to the later and main orders being for British-made material.

A lower quotation has undoubtedly been the main—if not the only—factor that has caused the placing of orders for foreign-made rails. A low quotation is, however, far from being synonymous with low actual cost, as many items which are seldom taken into proper consideration come in in the case of foreign-made rails to swell their final cost.

Distance and expense often militate against the same enforcement of supervision, inspection and tests usual in the case of English-made rails, and in very many instances these have been entirely omitted for foreign-made material.

Even in the case of the Birmingham Corporation order for 1000 tons of rails—recently placed in Germany—no physical tests were specified. Yet the paramount importance of properly conducted tests and close supervision throughout the various stages of manufacture, by competent and thoroughly reliable inspectors, is evidenced by the well-known facts and published statements with regard to the large quantities of rejections there have been in foreign-made rails when subjected to such inspection. Rejections, however, are not entirely unknown with British-made rails.

Of late there has certainly been a considerable advance towards a high standard of perfection in the manufacture of tramway rails, and this will undoubtedly be very greatly assisted by the general adoption of the "British Standard" sections and specification of manufacture.

BASIC.

Westminster, December 16th.

CONSULTING ENGINEERS AND FOREIGN MACHINERY.

SIR,—The support unwittingly given to our foreign rivals by the Press of this country, in giving prominence to the news relating to the placing of contracts, is a stupid free advertisement, injurious to home manufactures. In one of the technical journals, a few weeks ago, there was an article on "Condensing Plants," and of the many machines described only one was made in Great Britain.

There are other things to which I think the attention of manufacturers should be drawn. There are many buyers of pumps and fittings in this country who think because the makers have a London address that the goods they purchase are made here. Then we have consulting engineers specifying in the contracts of British municipalities valves, pumps, and engine and boiler fittings of foreign make—no better or cheaper than British made goods.

On the imposition of a duty on manufactured goods there may be a difference of opinion, but I am sure that the imports of foreign machinery could be cut down one-half, if the buyers and their agents would—other things being equal—give the preference to machines made in this country.

On board ship, and in many mills and works, foreign-made machinery can be seen. I find that generally the owners have held the erroneous opinion that it is British-made. This city of Manchester is one of the greatest sinners; its electrical stations being full of American and German machinery. The boiler-feed pumps at the Salford electrical station are of foreign make. The new Midland Hotel is fitted throughout with radiator valves and heating appliances of American manufacture. I do not blame the Manchester or Salford committees of the directors of the Midland Railway, as I am sure they are innocent that such a state of affairs exists. The consulting engineers are more to blame than any other body; it is a misfortune that many of the civil engineers are ignorant of the mechanical trades, and although wishing to be patriotic, their policy is really most detrimental to the interests of the country.

I, as an engineer, want a fair field and no favour, and I make a practice of never purchasing foreign manufactures if I can get British at the same price. The appliances which I have mentioned are dearer than those of British manufacture.

Manchester, December 18th. LANCASTRIAN.

MOTOR CAR STEERING GEAR.

SIR,—In Herbert's "Encyclopædia," published about 1840, there is a drawing of Trevithick's high road motor and a history of the various attempts at steam motors up to that date. While on the subject it may not be generally known that Hancocks, of Stratford, was the most successful; his carriages worked for two or three seasons from King's Cross to Stratford, passing through the City traffic without difficulty. I have seen them running and steering with ease. Why the Ackerman steering gear has been adopted by the motors of to-day surprises me. When this patent was taken out in 1820, several private carriages were fitted with it, but the wheels struck and would not follow the horse. Rock, of Hastings, tried to re-introduce it about 1850, but he failed to overcome the defect.

The present gear is the same, but being pushed, not drawn, the defects that the forward draught discovered still exist, and does not this in some measure account for the lateral strike of the hind wheels when turning? Now, taking the hind axle as a base, and erecting two triangles whose apex shall intersect the turning pivots which have to control the steering, it does not appear that this arrangement is mechanically correct. In practice it has undoubtedly led up to a number of serious accidents. If we take the same base, we have, instead of two scalene triangles, an isosceles triangle, its apex terminating at the central and single perch bolt, and from this point the hind axle and wheels are under proper control. Hancocks adopted the single perch bolt, and with what we should now call heavy and awkward vehicles, he steered without difficulty. This point should be clearly discussed, as it only involves the raising of the frame and body for the front wheels to turn under, and the striking of the hind wheels would probably cease, and steerage up to the restricted speed be easy and perfect. Being in my seventy-ninth year I am not disposed to enter into any controversy; having started the subject, would like others to discuss it.

Hayward's Heath, Sussex, ARTHUR KINDER.

December 19th.

CONSERVATION OF ENERGY.

SIR,—Your very interesting article on the above, which appeared in your issue for the 27th ult., induces the hope that attention may be directed to the further elucidation of this difficult subject in your columns.

I confess I do not see much use of "ions" myself, although they have come into great requisition lately to explain certain phenomena, which can, however, be as easily explained without their assistance. Their exclusion from the English language appears to be assured in the near future, a beginning having been already made—timorously, no doubt, as if the writer feared the consequences of his temerity! But a little pluck, and the thing is done. For if, after all, words signify little, the spelling must be of even still lesser importance; and we may write at once—if somewhat inelegantly, yet at least consistently and tersely—that the "conservat of energy really means the conservat of mot."

December 16th. R. W. S.

GOLD DREDGERS.

IN our impression of 4th inst. we gave two half-page illustrations of a gold dredger recently constructed by Messrs. Lobnitz and Co., Limited, of Renfrew, and we now return to the subject, as promised, and give further details of the dredger in question. In the works of this firm, however, as a recent visit of our Clyde representative clearly showed, gold dredgers of one type and another are almost constantly under progress, and some of the particulars here given may have an application wider than the particular production we illustrated. This dredger was built under the inspection of Messrs. Inder and Henderson, the consulting engineers to the Duff Development Company. It is a complete dredger, in the sense that both the hull and the overhead framework are of steel construction. In many cases, of course, the companies ordering these very special craft stipulate for a design involving the manufacture of the essential and more mechanical parts, such as engines, winches, gold tables, screens, buckets, bucket-ladders, tumblers, rollers, links, bushes, pits, &c., in this country—and for the supply and construction—of the pontoon or hull portion in the region in which the dredger may be destined to work. The question as to whether the whole production will be made of steel, or partly of steel and timber, and supplied wholly or in part by the one firm, depends on the exigencies of climate, configuration and nature of working site, and on the near adjacency, or otherwise, of the site to suitable supplies of timber, &c. Lobnitz and Co., as a matter of fact, supply as many complete dredgers, in the sense of furnishing and fitting combined timber and steel structures, as they do productions consisting wholly of metal, such as in the case of the particular dredger under notice.

Our illustrations showed a dredger erected complete in the builders' works, the steel hull and framing and the machinery all being fitted in place as when ready for work. Three types of gold dredgers are ordinarily produced by the firm, all being similar to those which have been developed in the New Zealand rivers. The A or first type suits best in a sandy bottom, or very small gravel in rivers or the sea beach, having neither a screen nor elevator, features which are so essential in the C, or third type. The B, or second type, applied to the same service as type A, having a screen, has the advantage that, where the gold has to be separated from stony soil in which it is embedded, it extracts a larger percentage of the gold.

Besides being able to do anything that types A and B can do, the type C, which our illustration refers to, can cut into river banks or beds of gravel above water level, and being fitted with a screen and elevator, can properly treat any gold-bearing river, or dry land where a little water is obtainable. As the builders have often to supply dredgers built to suit conditions of soil and working which are not accurately known, the designs are so made that type A can be converted into type B, or type B into type C. In this way the dredger, although ordered without knowing the purpose for which it is required, can be readily converted to suit it, even if a mistaken type has been adopted in the first place. All parts are correctly proportioned for their work, so that the liability to break down is of the smallest. Made by modern machinery to accurate gauges, and with all parts standardised and interchangeable, quick delivery and convenience of accurate fitting are ensured.

The dredger illustrated was constructed to have a dredging depth, with bucket ladder, of 30ft., and an elevator length, for disposing of the tailings, of 50ft. between centres of tumblers. There are thirty buckets on the dredging ladder, each having a capacity for five cubic feet of spoil. They have cast steel backs, with efficient wearing lips, and are shaped to discharge freely. The bucket chain is provided at intervals with three grab hooks, instead of an equal number of buckets, and made so as to be interchangeable with them. The grab hooks are for loosening and lifting boulders. The spoil is discharged through a shoot into the revolving screen, which, in the case of the dredger illustrated, is 22ft. 6in. long, 4ft. 6in. diameter, and perforated with as many as 50,000 holes, tapered from inside outwards. One of our illustrations herewith shows a special arrangement of drilling machinery devised by the firm for drilling and tapering these screens with expedition and accuracy. The drilling levers are actuated by boys, one boy in charge of two levers, and the turning of the screen and pitching of the holes are operations looked after by an older attendant. The screen, as fitted in place, is arranged on an inclination, and is capable of adjustment to suit the nature of the spoil. The driving gear is of a durable character, and the races and screen rollers have ample surface. There is efficient and adjustable water spray for properly washing the gravel. The heaviest boulders lifted by the buckets can, by special devices fitted, pass through the screen without in any way injuring the screen or elevator. This saves much time, as, instead of having to stop to lift boulders out of the buckets, they can be safely passed out of the top tumbler along with the finer gravel, without any undue wear to the machinery. The fine material passes through the holes in the screen directly on to ample steel tables for catching the gold, arranged on a suitable incline, and adjustable. On these tables matting is arranged, covered with expanded metal to serve as efficient riffles, and save the finer gold. The gold tables are of ample height, and can be readily increased in area two or three times over if it is found that the gold is too fine to be caught on the standard surface, which is made ample for the average required. The washed gravel and boulders are discharged from the lower end of the screen through a discharge shoot into the trays of the elevator, which elevates and stacks the tailings at a convenient height behind to enable the dredger to work into the gravel banks. The elevator can be made longer and shorter as desired by means of different positions being arranged for the upper tumbler.

Asked by our representative as to whether the firm had yet adopted in any of their productions the centrifugal mode of dealing with the tailings, such as has been introduced of late in some of the New Zealand dredgers, Messrs. Lobnitz and Co. answered in the negative. The invention in question is that of two New Zealand engineers, Messrs. Peck and Payne, and is intended to do away with the elevator as used hitherto in gold dredgers. The machine consists of a wheel or drum with beaters or vanes somewhat similar to a water wheel, and it simply throws the stuff away, promiscuously, with great force, thus obviating the need for the present elevator, with its top and bottom tumblers, its trays, chains, pins, bushes, &c.

For manœuvring the dredger specially under notice a powerful winch is fitted on deck—as shown in our former illustrations, and as now illustrated in more detail. As will be seen, it is completely fitted with wire-rope drums for ladder hoist and manœuvring lines. All the drums have efficient clutches, the brakes are lined with wood blocks, and all the handle gear is so arranged that one man can readily handle the dredger. The winch engine is reversible, and the spur wheels throughout of cast steel. The main engines are of independent, two-crank, horizontal, compound surface-condensing type, efficiently governed, and they, as well as the boilers, are made by Marshall, Sons and Co., Limited, Gainsborough, of the type common in the New Zealand dredgers. The working pressure of steam is 140 lb. All parts of the machinery, &c., are so arranged that the dredger can be worked continuously and conveniently with, in all, a crew of six men and master; that is, twenty-four hours' work per day—three shifts of two men for eight hours each—the machinery being so conveniently arranged that two men can run the dredger in ordinary work.

The smallest size of dredger made by Lobnitz and Company, Limited, is a "prospecting" dredger of the bucket type, which two men can work. The smallest size of regular gold dredger suitable for running night and day requires a crew of two men per shift—say, six in all in the twenty-four hours. This machine will lift and properly treat per day as much gravel as 1000 men could do with the hand rocker and washing arrangement. Besides the enormously increased amount treated and the economical outlay in so doing, the great advantage with this type of machine is that the bucket ladder can be lowered to a greater depth below natural water level, and so reach rich beds of gravel which are quite unattainable by ordinary hand-washing; and it often occurs that the richest gold, owing to its weight, is found at the deepest depths.

THE report of the Government engineer who conducted surveys of possible railway lines from Manila to the north, both by the central route and by the west coast of the island of Luzon, and from Manila southwards to Batangas Bay has been published. The suggested line from Manila north to Aparri follows the valley of the river Pampanga on the left bank to its head, thence over the Caraballo Pass and down the Magat and Cagayan River valleys, *vid* Bagabag, Ilagan, and Nagsiping to the terminus at Aparri. The West Coast line is intended to start from Dagupan, which is already connected by rail with Manila, and to pass near Tagudin, thence through or near Santa Cruz, Vigan, and Santo Domingo to Laoag, the terminus. The line from Manila south to Batangas should touch Calamba, cross Rio San Juan and proceed *vid* Lipa to the terminus.

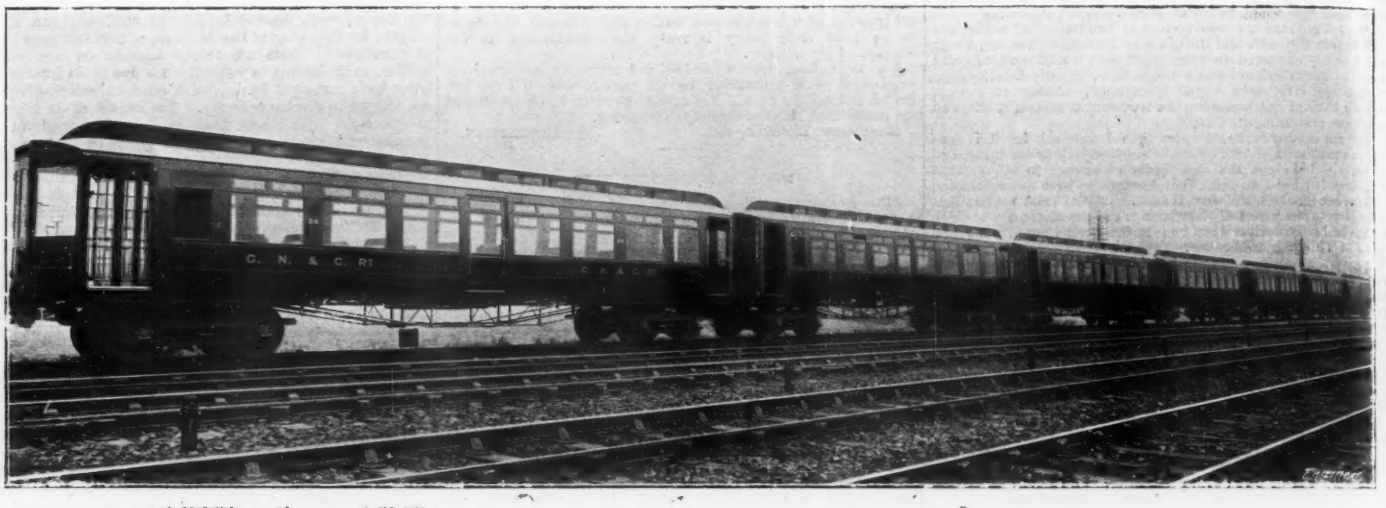
THE ROLLING STOCK OF THE GREAT NORTHERN AND CITY RAILWAY.

THE Great Northern and City Railway, which has taken ome four or five years to construct, is now nearing completion, and will, it is expected, be opened for public traffic in the course of a few weeks. Already a large number of the carriages for use on the railway has been delivered. They have been constructed to the order of Messrs. Pearson and Son, the contractors, by the Brush Electrical Engineering Company, of Loughborough and London, and built to the designs of Sir Douglas Fox and Partners. The trains—as will be seen from the accompanying illustration—are made up of seven coaches, three of which—the two end and two middle ones—are equipped with motors to be used on the multiple unit system. The motor coaches have the following principal dimensions :—

	Ft.	In.
Length of body, outside	40	8
Length, over platforms	49	6
Width, over side pillars	9	4
Width, inside, clear	8	9
Height, inside, at the centre	8	4
Height of doorway, clear	6	3
Width of doorway, clear	2	10
Distance of bogie centres	34	6
Wheelbase of bogies	6	1
Gauge of line	4	8½
Seating capacity	Sixty passengers	

The cross section is designed to comply with the conditions of the Great Northern Railway loading gauge for maximum rolling stock and minimum structure. The construction of these coaches consists of a steel channel section underframe, the sole bars of which are filled with a pitch pine timber the whole length of the car for the reception of the body frame. Two channels run the whole length of the underframe, to which the floor members are securely bolted, the whole being braced diagonally and trussed both transversely and longitudinally. The floor boards are 1in. red deal, two layers in thickness, running in opposition directions. The roof is of the clerestory type with swinging sashes, pivoted for ventilation. It is supported by channel and flat ribs, and strengthened by a number of flat steel carlines, 2in. by ½in., carried across the top and down the sides of each cant rail. The roof boards are of red deal, ⅜in. thick, tongued and grooved, and covered with prepared roofing canvas laid wet on two coats of white-lead paint. Sliding doors are provided in the centre and at both ends, framed in teak and glass panels. They are suspended from the top by brass hangers carrying friction rollers. The entrance platforms are 4ft. 5in. long, and are fitted with automatic locking gates on each side. Each platform has a permanent vestibule front with a double swing door. Every two adjacent gates are arranged so that they can be easily controlled by one man standing in the gangway. The interior finish is of teak, panelled with mahogany; these panels between the windows are inlaid with sycamore and pressed teak moulding. The other mouldings are of teak, the roof being finished with Lincrusta millboard painted dull white and divided into eight transverse panels. The cars are provided with thirteen cross seats on each side, giving accommodation for two passengers on each; the remainder of the seating capacity consists of short longitudinal seats at either end, ample room being allowed each passenger. A combination vertical grab handle and hat rack of ornamental pattern is fitted to the top of each seat frame. The seats and backs are of the best quality spring rattan in mahogany frames. Each door is provided with an automatic spring lock, and these, together with the various handles and other metal furniture, are of lacquered brass of substantial design. The electric lighting consists of fifteen 16 candle-power lamps, fixed to the rails underneath the ventilators on each side and to the end bulkheads. The fittings are arranged to carry a cut-glass pear-shaped globe. A portion of the car, 2ft. 10in. long, at one end, is partitioned off for the reception of the electric control apparatus.

This compartment is lined with sheet iron and asbestos, to ensure complete protection against fire from any of the electrical gear. An oil lamp is fitted over the inside of each doorway for use when the current is cut off. The internal woodwork is French polished and finished off with a coat of pale varnish. Outside, the cars, which are completely panelled and framed in teak, are got up natural grain, and finished in varnish. The ironwork of the underframes is painted with best chocolate oxide. Each coach is lettered "G.N. and City," in 5in. gold block shaded letters on the centre waist panel, the number being painted in two places on panels between the windows at each end of the coach. The trailer coaches are of the same general design and construction as above, except that the platforms are not vestibuled, but are fitted with an iron screen 4ft. 6in. in height, carried round the end of each gangway, and fitted with the similar type of wrought iron locking gates. The Brush "heavy service" trucks, type "E," have been provided. The trucks have cast steel sides, inside brakes, and a swing bolster, which ensures very steady running. These trucks have been designed for the heaviest service, with speeds as high as 80 miles per hour. The wheels are steel tired with wrought iron centres. Both motor and trailer coaches are provided with the Westinghouse quick-acting brake, the motor coaches being also fitted with an efficient hand brake, which can be operated from either platform. Air pumps, electrically driven, and automatically controlled, are situated in each conductor compartment. Central radial spring couplers, which also act as buffers, are supplied. Collapsible iron gates are fitted to the opposite corners of each car, so as to be interchangeable when coupling the cars. Hinged cross-over plates are used to provide a gangway between the adjacent platforms, the latter being protected by wrought iron fencing.

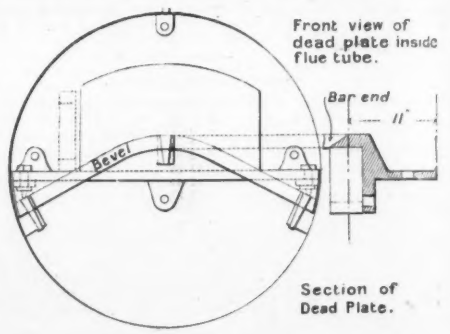


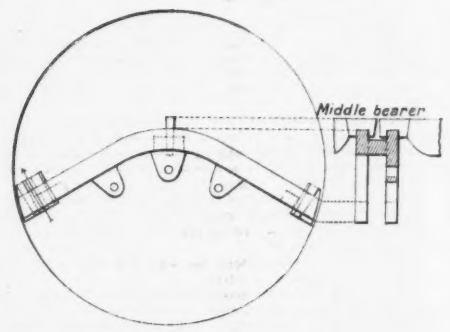
TRAIN FOR THE GREAT NORTHERN AND CITY RAILWAY

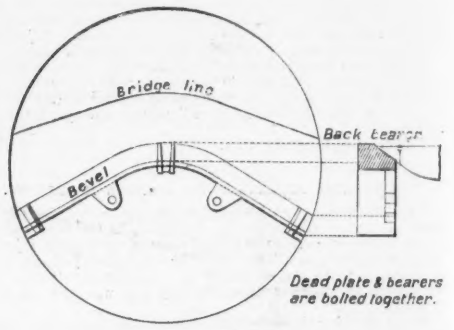
INTERIOR OF COACH

A NEW FURNACE GRATE.

THE accompanying engravings represent a new furnace invented and made by Mr. G. Richardson, Willoughby-place, Holbeck, Leeds. It will be seen that it is of that type in which the bars are arched upwards in the middle. The details of construction are quite clearly shown; the bearers rest on the dead-plate, which in turn rests on two brackets rivetted to the furnace tube. The ashpit is open, but steam jets are fitted to assist draught if necessary. In the split bridge is an air-way to prevent smoke, which is controlled by a damper valve.







We understand that the results obtained with this grate are very satisfactory.

TESTS OF ELECTRIC CONDUCTIVITY OF TRAMWAY CONDUCTOR RAILS.*

FOR certain classes of electric railways a steel conductor is preferable to the older and more commonly used overhead trolley-wire, and is particularly suitable for high-speed and heavy service. With costs calculated on the basis of equal conductivity in rail and trolley-wire, the third-rail construction is cheaper than the overhead trolley. But the average interurban road will use a trolley-wire of considerably less conductivity than would be obtained with the smallest size steel rail (about 60 lb. per yard) that would ordinarily be used, and here the first cost of trolley construction would generally be less than that of the third-rail. The cost of maintenance of the third-rail construction should be less than that of the overhead trolley. This consideration, together with that of sightliness and adaptability (particularly in the case of terminals, yards and very heavy or high-speed service), will frequently offset the higher cost of the third-rail construction and make it the preferable means of conducting the current from the generator to the car motor.

For the first third-rail installations, old track rails were used, supplemented with new rails of section and composition the same as the track or running rails. With the coming of the very heavy, high-speed service during the past few years, the resistance of these rails was found to be so high that they would not carry the high currents necessary without too great a drop in the line-potential. The rails would, therefore, have to be supplemented with additional copper feeders, but as this would be an expensive way to overcome the trouble, rails of higher specific electric conductivity were sought.

Because of the lack of specific data on the relation between conductivity and composition of mild steels, specifications for conductor-rails have usually been based on the fact that the conductivity of a metal is generally more or less directly in proportion to its purity. In most cases the purity of the iron specified for such rails has been so high that not only was it difficult to obtain, but the iron was also correspondingly of high price. One of the factors governing the choice between a third rail and a trolley wire is the relative price of steel and copper, allowance being made for the difference in conductivity. Hence, a balance must be struck between high conductivity—which is equivalent to saying a high degree of purity or freedom from the usual metalloids associated with iron—and the cost of producing the steel of the composition necessary for the conductivity required.

On entering the market with an order for rails of special composition, difficulty was encountered in interesting railmakers, and the reason became apparent. The mills which make the standard flange rails, or standard rails of other sections—such as the girder and grooved rails—have generally been designed with the object of making such rails only, and practice throughout has been standardised to the greatest possible extent, both in the manipulation of the steel and in its manufacture in the furnace or converter. Hence, an order, even of considerable extent, for rails of special composition, has so upset the routine work that it was considered a nuisance to be endured, rather than a desirable business to be sought for. Obviously, then, recourse must be had to mills where such special compositions can be handled economically.

For the third or conductor rail there must be provided sufficient surface for the collection of the current, and cross-section ample to carry the current without an undue drop in the line potential. The strength of the section is of little moment, and any section which is easily installed in an insulator is satisfactory. This permits the use of sections rectangular, or nearly so, which may be rolled easily in any mill equipped for the rolling of merchant-bar shapes of reasonably heavy weight, without any change in equipment or practice beyond the provision of grooved rolls of the necessary shape. Mills rolling merchant-bar or structural steel to-day are generally equipped to make steel in the open-hearth furnace, which readily lends itself to the making of steel of the special composition demanded by the electrical engineers for the third or conductor rail.

To provide steels of sufficient range to give some indication of the relation between conductivity and composition, we obtained from as many of the steel makers as we could interest samples representing all of their common products. Some of the makers kindly provided us also with samples of special steels made in crucible charges. The samples were mainly forged or rolled bars of from 1in. to 2·5in. in diameter, and from them were turned bars of 0·75in. in diameter, or 1in. in diameter by 24in. in length, on which resistivity was determined. The chips from the finishing cuts were collected, and these furnished the samples for analysis. Also, we cut similar bars from the heads of T-rails, which were to be found in the yard tracks.

Table I. states the electrical resistance and the chemical composition of ten samples of steel,† and Table II. similar data on seven samples of wrought or refined iron, together with results on three samples of iron reported by Barrett, Brown and Hadfield in a paper referred to later in this article. The samples were numbered serially in the order of their resistance, No. 1 being of the highest resistance. Samples Nos. 1, 2, 4, and 5 are standard flange rails from several well-known makers. No. 10 is a T-rail used by the Underground Electric Railway Company of London, and ordered from a steel maker in Westphalia. Samples Nos. 1, 2, and 3, Table II., are ordinary refined bar iron, while Nos. 4 and 5 are special brands of refined bar iron sold for use in staybolts and similar work. Nos. 6 and 7 are Swedish and Norway irons respectively.

The resistance is expressed in the three ways in which such results are frequently stated. The first column gives the specific resistance or resistivity of a section 1 square centimetre in cross-section and 1 centimetre long, expressed in microhms (ohms × 10^{-6}), and at the temperature given in the second column. In the third column is given the conductivity (on the basis of Matthiessen's determination of the resistivity of pure copper)—*i.e.*, the ratio of the resistivity of copper to that of the sample, expressed as a percentage. The fourth column gives the resistance of the samples compared with Matthiessen's copper as unity (the figures in the fourth column are the reciprocals of those in the third column multiplied by 100). The second half of the table gives the percentages of the usual elements to be found in steel or iron, the total percentage of these elements, and the sum of the percentages of phosphorus, sulphur, and silicon.

The coefficient of change of resistance with change of temperatures is practically the same for copper and for ordinary steel and iron; hence, even though resistivities are determined at different temperatures, the conductivities or comparative resistances derived therefrom are directly comparable within limits close enough for the purpose of this discussion, without actual determinations of the temperature coefficent in each case, and the reduction of results to a basis of common temperatures. Therefore, in all succeeding reference to results, the resistance will be expressed as in the fourth column, *i.e.*, the ratio of resistivity of sample to that of Matthiessen's copper.

The resistance of steel, as of other alloys, might be expected to vary more or less directly with its purity. Therefore if a curve were plotted of resistances and total percentages of metalloids, this would indicate that the increase in resistance, due to increasing percentages of metalloids, becomes gradually greater up to about 0·75 per cent. of metalloids, after which it follows a straight line up to about 2 per cent. of metalloids. Beyond this latter point our samples did not extend.

TABLE I.—*Resistance and Composition of Steel.*

Serial number	Specific resistance. Microhms per Cm Cm²	Specific resistance. Temp., deg. Cent.	Conductivity. Matthiessen standard.	Resistance. Cu. = 1.	Percentage Composition. C.	Mn.	P.	S.	Si.	Total. Not Fe.	P. + S. + Si.
1	22·72	19	7·58	13·20	0·33	1·27	0·09	0·05	0·05	1·79	0·19
2	20·90	20	8·27	12·12	0·17	1·09	0·09	0·05	0·004	1·404	0·144
3	21·29	25	8·27	12·09	1·40	0·222	0·01	0·020	0·082	1·734	0·112
4	19·87	19	8·65	11·55	0·20	0·95	0·10	0·08	0·05	1·38	0·23
5	14·49	20	11·88	8·42	0·25	0·41	0·10	0·04	0·03	0·83	0·17
6	13·88	19·5	12·44	8·04	0·10	0·55	0·08	0·05	0·024	0·804	0·154
7	12·87	20	13·27	7·48	0·16	0·38	0·08	0·04	0·009	0·669	0·129
8	12·60	19	13·55	7·38	0·19	0·21	0·025	0·04	0·034	0·499	0·099
9	12·53	19	13·74	7·28	0·215	0·22	0·051	0·113	—	0·599	0·164
10	11·01	19	15·63	6·40	0·05	0·19	0·054	0·059	0·03	0·383	0·143

TABLE II.—*Resistance and Composition of Iron.*

1	13·80	25·5	12·78	7·82	0·15	0·068	0·13	0·02	0·15	0·518	0·30
2	13·82	26	13·37	7·48	0·15	0·064	0·086	0·02	0·13	0·400	0·186
3	13·10	26	13·50	7·41	0·16	0·074	0·12	0·027	0·10	0·481	0·247
4	12·54	25·5	14·07	7·11	0·08	nil	0·13	0·006	0·024	0·242	0·162
5	11·92	25·5	14·80	6·76	0·17	0·027	0·074	0·022	0·077	0·370	0·173
6	10·82	24	16·21	6·17	0·038	0·10	0·014	tr.	0·012	0·184	0·026
7	10·80	25·5	16·34	6·12	0·16	0·018	0·049	0·011	0·015	0·252	0·075
LSS	11·40	17	15·00	6·68	0·050	0·180	0·013	0·011	0·02	0·274	0·044
B	11·00	17	15·57	6·44	0·080	0·036	0·065	0·016	0·14	0·287	0·221
8CI	10·35	17	16·55	6·06	0·028	tr.	0·004	0·005	0·07	0·107	0·079

* From a paper by Mr. J. A. Capp, read at the October meeting of the American Institute of Mining Engineers.

† The author gives particulars of forty-five samples.

AN INQUIRY INTO THE WORKING OF VARIOUS WATER-SOFTENERS.*

By Mr. C. E. STROMEYER, Member, of Manchester, and Mr. W. B. BARON, of Manchester.

IT has frequently been stated that scale seriously reduces the heat efficiency of boilers, and experiments have been made which seem to prove this assertion, but it will be found that they have been carried out on wrong lines, and they only prove that scale very seriously interferes with the transmission of heat if the heat source, usually a flame, is of equal temperature over the whole surface. In a boiler the temperatures vary from 3000 deg. to 4000 deg. Fah. at the furnace down to 500 deg. to 1000 deg. Fah. where the gases leave the boiler. Let us take a simple case, assuming, for convenience of calculation, that the heat transmission from flame to boiler plate is proportional to the difference of temperatures. Let the ratio of air to fuel be as 20 to 1; let the air temperature be 80 deg. Fah., then the flame temperature will be 3000 deg. Fah. If the steam temperature is 380 deg. Fah., the maximum temperature of the furnace plates will, in the above example, be only 20 deg. Fah. higher than that of the steam, viz., 400 deg. Fah. Now let us assume that the heating surface is covered with scale ⅛in. thick; then if the same quantity of heat were transmitted through the coated furnace plates as through the clean ones, the temperature difference between one side of the scale and the fire side of the furnace would be 350 deg. Fah., and the temperature of the plate would be 730 deg. Fah. It is, however, clear that as the boiler plate is hotter than in the first example, less heat will be transmitted to it, and the temperature gradient in the scale will be less steep. Naturally, also, the flame will not get cooled so rapidly, and its temperature as it reaches the next portion of heating surface will be higher than before. The temperature distributions will therefore be roughly as follows:—

TABLE I.—*Temperature Distribution in a Boiler.*

Square feet of heating surface per pound of fuel per hour	0	¼	½	1	2	4	8
	Boiler with plates free from scale.						
Flame and flue temperature, deg. Fah.	3000	2421	1961	1335	728	426	381
Maximum plate temperature, deg. Fah.	400	396	392	387	383	381	380
Total heat transmitted, per cent.	0	19·8	35·6	57·0	77·8	89·2	89·7
	Boiler with scale ¼in. thick.						
Flame and flue temperature, deg. Fah.	3000	2484	2070	1471	835	459	384
Maximum plate temperature, deg. Fah.	691	630	581	510	434	389	382
Total heat transmitted, per cent.	0	17·5	31·8	52·4	74·2	87·0	89·5

Boilers are generally designed to have 1½ square feet to 2 square feet of heating surface per pound of fuel burnt per hour under ordinary working conditions. Four square feet in Table I. represents a lightly-worked boiler, and ¼ square foot represents the heating surface usually swept by the flame.

It will be seen from the table that even for this small value of heating surface to fuel the addition of scale ⅛in. in thickness only reduces the transmitted heat by 11·6 per cent., whereas when the gases reach the end of a lightly-worked boiler, where this value is 4, we find that the total reduction has fallen to only 2·5 per cent. We may therefore safely say that even a thick coating of scale does not materially reduce the efficiency of a boiler. On the other hand, Table I. shows very clearly that even ⅛in. of wet scale raises the temperature of the furnace plate in this case by nearly 300 deg. Fah.

In this particular instance there is therefore danger that the furnace has been sufficiently weakened by heat to be nearly collapsing. Scale is thus a serious danger, and, as is well known, has frequently caused accidents. It will be noticed that in clean boilers the temperature of the furnace plate is nearly the same as that of the water, whereas in the scaly boiler the excess temperature is about one-tenth of that of the flame. If, therefore, in the first case we open the furnace door and admit cold air, the excess temperature of the furnace plate can at most be reduced 20 deg. Fah., causing a contraction of only $\frac{1}{10}$in. in 8ft., whereas cold air admitted to the furnace of the scaly boiler will effect a rapid reduction of about 311 deg. Fah., accompanied by a contraction of ¼in. in 8ft., which is a very serious matter. In fact, in a rigid structure these two strains would be accompanied by stresses of 1·5 and 22 tons respectively. Boilers are elastic, but a large fraction of these stresses certainly make their appearance every time that a furnace door is opened, say once every half-hour, or 6,000 times a year. No wonder, therefore, that in high-pressure boilers, which are necessarily more rigid than low-pressure ones, this constant straining leads to grooving at the furnace flanges. With scale ¼in. thick the stresses would be nearly doubled.

We thus see that scale does not materially reduce the efficiency of the boiler, but it seriously increases its wear and tear, whereby its life is considerably reduced. It also endangers the safety of boilers. The same remarks apply to coatings of grease due to feeding the boiler with water containing condensed steam from the engine. It is therefore desirable to remove all scale-forming impurities from the feed water. These impurities are suspended matter, carbonate of lime, sulphate of lime, magnesium salts and grease. One has also to be on one's guard against introducing large quantities of soluble salts, as these concentrate when the water evaporates, until thick scales of crystals are formed.

Let us examine the behaviour of these various impurities.

Suspended matter is often organic, and appears to have a beneficial effect on such mineral precipitates as may be formed by combining with them and forming loose sediment, which is easily dealt with in water softeners, or it settles down as mud in boilers. Some suspended matter, such as fine sand, and more particularly paper pulp, settles on the furnaces and leads to collapses.

Carbonate of lime is the chief cause of temporary hardness.—Its chemical formula is $CaCO_3$. It is practically insoluble in water, but it is easily converted into bicarbonate of lime, having the formula $CaH_2(CO_3)_2$, which is fairly soluble in cold water, and is a constituent of most natural waters. Its second equivalent of carbonic acid is easily removed on boiling, when, of course, the carbonate of lime is precipitated, forming a scale. The slower this reaction is carried out, the slower the heating, the more chance is there for this carbonate of lime to form crystals—called calcite in mineralogy—which constitute a fairly hard scale, as found in economisers, where the conditions are very favourable to its production. This explains why, in the south of England, where the waters contain much temporary hardness, economisers are very little used, for they would get choked unless the waters be first softened. Waters poor in carbonate of lime but rich in sulphates do not choke the economiser pipes. If the heating is effected rapidly, as, for instance, when natural waters are pumped direct into the steam space of a boiler, the precipitation of carbonate of lime is so rapid, that only a mud is formed. Another means of converting bicarbonate of lime into carbonate of lime is to add solutions of caustic lime, burnt lime, or caustic soda, in water. The chemical reaction is as follows:—

Bicarbonate of calcium $Ca H_2 (CO_3)_2$ Soluble	+	Caustic lime $Ca O$ Soluble	=	Carbonate of lime $2\,Ca CO_3$ Insoluble	+	Water H_2O Water

The second equivalent of the carbonic acid in the bicarbonates of lime and of magnesia is generally called half-bound. Any excess is called free carbonic acid. Of course, sufficient lime is required to neutralise both.

In the table of chemical analysis the bicarbonate of lime is split up into carbonate of lime and carbonic acid, because the latter disappears on boiling. One grain of carbonic acid combines with 2·27 grains of carbonate of lime, forming 3·27 grains of bicarbonate of lime. Temporary hardness cannot be entirely removed by lime treatment, because carbonate of lime is not absolutely insoluble.

Sulphate of lime.—The chemical formula is $CaSO_4$. It is fairly soluble in water up to the boiling point at atmospheric pressure, but it is less soluble at temperatures corresponding to high pressures of steam. Because this sulphate of lime cannot be removed by ordinary boiling it is called permanent hardness. One grain of sulphate of lime equals 0·7350 permanent hardness. The result is that, if waters containing sulphate of lime are pumped into a boiler, the constant evaporation effects a slow concentration until saturation point is reached, when the sulphate of lime is precipitated so slowly that it crystallises and adheres to all parts of the boiler, but more particularly to the hottest parts; then, whenever the pressure drops—and with it the temperature—part of the precipitate is redissolved, the spaces between the crystals are filled with concentrated solutions of sulphate of lime, which crystallises out again on heating, whereby the originally small and loose crystals are enlarged and are firmly cemented together, forming a very hard scale, which can only be removed by chipping or by heating; it is practically gypsum or selenite. If any carbonate of lime is mixed up with the scale, this too gets thoroughly cemented with it.

At the temperatures corresponding to high pressures, water can dissolve only about 20 grains of sulphate of lime per gallon. On cooling down a boiler and letting it stand for some time, the water will dissolve parts of the crystals until there are about 170 grains to the gallon. This dissolving action loosens the scale, which can be easily removed as long as it is wet. If the scale be allowed to dry, all the 170 grains of sulphate crystallise and thereby cement together the loose parts of the scale, making it hard and difficult to remove.

The principle of pumping feed water into a trough in the steam space of a boiler has several times been patented, but as boiler water can hold up to 20 grains of sulphate of lime in solution, this method is of no benefit with waters having less permanent hardness than 15 deg.

The sulphate of lime can always be entirely removed by conversion into carbonate of lime. The reaction is as follows:—

Sulphate of lime $Ca SO_4$ Soluble	+	Carbonate of soda $Na_2 CO_3$ Soluble	=	Carbonate of lime $Ca CO_3$ Insoluble	+	Sulphate of soda $Na_2 SO_4$ Soluble

If there is any free or half-bound carbonic acid in the water—and this is generally the case—caustic soda, if available as a waste product, may be used. The caustic soda combines with the carbonic acid to form carbonate of soda, and the reaction is then as sketched above, and the lime which has lost its one equivalent of half-bound carbonic acid is also precipitated. Caustic soda without carbonic acid will not precipitate the sulphate of lime. It is, therefore, wrong to introduce caustic soda into boilers which are fed with water having only permanent hardness. In fact, caustic soda should not be pumped into a boiler except together with the cold feed, for as long as the water is cold the carbonic acid can be fixed, and additions of caustic soda would come too late if made in the boiler.

The above sketched chemical reaction can easily be carried out in water softeners, but the separation of the precipitate is as slow as in the last case, and unless heat is applied the newly-formed carbonate of lime has to settle for a long time.

Magnesium salts.—These are found in natural waters as nitrates, chlorides, sulphates, and cause permanent hardness, or as bicarbonate, which causes temporary hardness; they are very soluble, except the last-named. They all react on soap, and heat will not precipitate them, except the bicarbonate by driving off its carbonic acid. At the high temperatures to be found in boilers a reaction resulting in precipitation of magnesia takes place between the carbonate of lime and the soluble magnesium salts. The bicarbonate of magnesia can be partly removed by converting it into carbonate of magnesia by the addition of caustic lime.

The reaction in water softeners is as follows:—

Bicarbonate of magnesia $Mg H_2 (CO_3)_2$ Soluble	+	Caustic lime $Ca O$ Soluble	=	Carbonate of magnesia $Mg CO_3$ Slightly soluble	+	Carbonate of lime $Ca CO_3$ Insoluble	+	Water $H_2 O$ Water

* The Institution of Mechanical Engineers.

The last traces of magnesium carbonate are removed by adding an excess of lime, the reaction being as follows:—

$$\begin{matrix}\text{Carbonate of magnesia} \\ Mg\,CO_3 \\ \text{Slightly soluble}\end{matrix} + \begin{matrix}\text{Caustic lime} \\ Ca\,O \\ \text{Soluble}\end{matrix} + \begin{matrix}\text{Water} \\ H_2O \\ \text{Water}\end{matrix} = \begin{matrix}\text{Hydrate of magnesia} \\ Mg\,(OH)_2 \\ \text{Insoluble}\end{matrix} + \begin{matrix}\text{Carbonate of lime} \\ Ca\,CO_3 \\ \text{Insoluble}\end{matrix}$$

The other magnesium salts react in a similar way, being easily converted into carbonate and hydrate by the addition of burnt lime and soda ash.

The carbonate of magnesia, $Mg\,CO_3$, is very slightly soluble in water, whereas the hydrate of magnesia $Mg\,(HO)_2$, is practically insoluble, but being a gelatinous mass it causes serious difficulties in water softeners, more especially by clogging the filters.

Grease.—This is, of course, only found in the waters discharged from jet or surface condensers or from feed-heaters in which steam is condensed. Vegetable and animal fats cause corrosion in boilers, but as they are unsuitable for cylinder lubrication, they are now rarely used and heavy mineral oils have been found to be more suitable. Modern marine practice tends towards the running of engines without any cylinder oil, but factory engines still consume large quantities, and thereby contaminate their feed-water if drawn from the condenser. Part of this grease floats on the water and could be removed by filtration; probably it does little harm if it gets into the boiler, but a small trace is emulsified in the water and is very difficult to deal with. It cannot be separated from water by boiling at atmospheric pressure, but it is completely removed by the conditions which exist in a boiler, and as it adheres to the heating surfaces it causes overheating, which may result in a collapse, and certainly increases the wear and tear.

The peculiarity of grease deposits in boilers is that there effect is out of all proportion to their thicknesses. We have seen that scale of $\frac{1}{16}$in. thickness will raise the temperature of furnace plates about 300 deg. Fah. As grease offers ten times more resistance to heat, one would expect that $\frac{1}{10}$in. would have the same effect as this thickness of scale, but experience shows that the merest trace of grease, certainly less than 1000th inch, or one-tenth of the above, can cause far more serious injury than scale. Various explanations have been attempted. According to one of these, thin films of grease form tough bubbles on the heating surface and prevent the water from keeping it cool. Another view is that grease, either alone or joined to mineral matter, forms an impalpable powder like oxalate of lime and other precipitates, and, like these, retards ebulition. In support of these views we find a fairly well-founded belief that grease in boilers is more injurious if these boilers are clean than if they are coated with mineral scale, and against this view we have the undoubted experience that land boilers with scale at once give trouble if condensed water is used instead of natural water. Increase of pressure above 110 lb. seems to accentuate this evil; perhaps this may be due to decomposition of magnesium carbonate when this temperature is reached. In any case it is highly desirable to remove every trace of grease from the feed-water. As already stated, this cannot be done by filters; and grease separators, which appear to be rather more efficient, do not remove the last trace of grease.

As yet the only effective method for doing this is to add mineral matter in solution to the condensed water and then to cause precipitation by chemical means. The grease then adheres to the precipitate and can easily be removed by settlement or filtration. Water from jet condensers contains the necessary mineral matter, but this has to be added if the waters are drawn from surface condensers. The preceding remarks may be here briefly summarised. Carbonate of lime forms hard scale in economisers and a soft mud in boilers, unless sulphate of lime is present, when it also is cemented into a scale. Carbonate of lime can be removed by boiling or by adding enough caustic lime or caustic soda to combine with the free and half-bound carbonic acid which holds it in solution.

Sulphate of lime forms no scale in economiser pipes, but it forms a very hard scale in boilers, and also cements the carbonate of lime deposits. Its deposition in boilers is due to slow concentration of the water, and it is therefore desirable to remove the salt entirely. This can always be done by adding carbonate of soda, which converts it into carbonate of lime.

Carbonate of magnesia generally behaves like carbonate of lime, except that it is slightly more soluble.

The other salts of magnesia are very soluble. They seem to cause corrosion and should be removed. This can be done by treating them like the sulphate of lime by adding carbonate of soda.

Grease should, if possible, be kept out of a boiler. Neither separators nor filters will remove it entirely from feed-waters, but this can be done by mixing them with impure waters and treating them in water softeners.

The cost of raising the temperature of 1000 gallons of water from 60 deg. to 212 deg. Fah. is about 1s. when the price of coal is 12s. per ton, no matter what the hardness of the water may be.

With waters of 10 deg. temporary hardness 1·14 lb. of caustic soda of 77 per cent. strength, or 0·8 lb. of burnt lime, will suffice for 1000 gallons of water. The same quantities will also neutralise all the free carbonic acid represented by 6 grains per gallon. As the prices of caustic soda and lime stand in the ratio of 12s. 6d. to 1s. per cwt., the relative costs of the two treatments would be 1·53d. and 0·09d. per 1000 gallons, and naturally one would use caustic soda only if it is a waste product and if there is permanent hardness also present. Large proportions of soda, either carbonate or caustic, affect brass fittings.

It requires 1·5 lb. soda ash of 58 per cent. strength to remove 10 deg. permanent hardness out of 1000 gallons. As the price of this soda is about 5s. 6d. per cwt., the cost would be about 0·88d. per 1000 gallons. The strength of washing soda is about 20 to 22 per cent.

In some water softeners, such as the Archbutt-Deeley, Lassen and Hjort, caustic lime and carbonate of soda are mixed, producing a milky fluid, which consists of caustic soda, free lime or free soda ash, and insoluble carbonate of lime, the latter substance being, of course, a useless constituent. The cost of the caustic soda so produced would be about 6s. per cwt.

The interest and depreciation of the softening plant, the attendant's time, generally only half-an-hour a day, have to be added to the above expenses. If the waters are treated in the boilers—when burnt lime may, of course, not be used—the cost of removal of the scale, and the wear and tear of the boiler, due to overheating, have to be added. The following Table II. shows the relative cost of working installations of from one to seven boilers. Each boiler is supposed to be 8ft. diameter, and to have cost £800, including setting, &c. The interest on the first outlay and on the sums annually set aside for depreciation and renewal is taken at 3 per cent. The best worked boiler using pure or softened water is supposed to last fifty years, and the last boilers on the table are supposed to last only fifteen years, and have to be opened out and scaled every three months. The other boilers, having each a spare one in the set, are supposed to last the number of years shown in the table. In each case except the first the water is supposed to be very sedimentary.

TABLE II.—*Hypothetical.*

Nature of feed.	Pure	Very sedimentary water.						
Boilers at work	1	1	2	3	4	5	6	6
Spare boilers	0	1	1	1	1	1	1	0
Assumed life of boilers	50	40	40	40	40	30	20	15
Interest on first cost, £	24	48	72	96	120	144	168	144
Depreciation .. £	7	21	32	42	52	100	209	258
Scaling and cleaning at 30s. .. .. .. £	2	20	30	50	78	78	78	36
Chemicals .. .. .. £	2	10	20	30	40	50	60	60
Total .. .. £	35	99	153	227	290	372	515	498
Totals per working boiler .. .. .. £	35	99	71·5	75·7	72·5	74·4	85·8	88*

* The actual cost would be much greater, as the works would be closed down for four weeks per annum.

It will be seen that, according to this estimate, boilers using pure water should not cost more than about £35 per annum, including chemicals in a water softener, whereas the other boilers using sedimentary water and boiler compositions may cost twice and three times as much. The minimum saving, say £30, capitalised at 5 per cent. represents £600, whereas the cost of a water softener per boiler would amount to about £100 to £200.

We have now to turn our attention to some of the practical difficulties which water softeners have to overcome, the most important of these being the proper adjustment of the supply of chemicals and the removal of the precipitates from the treated waters. If by suitable chemicals we precipitate carbonate of lime out of water, it is at first in a colloidal condition, its first appearance being that of a bluish-white thin starch, which can freely pass through the best chemical filters, and could never be arrested by wool, cloth, or sponges. If this fluid is allowed to stand for a considerable time, or if it is heated a little, the precipitate settles down, changing to a yellowish colour, and no amount of shaking will again convert it back to its original condition; but even now this precipitate is so fine that it settles down very slowly. According to Professor Wanklyn's experiments this precipitate will settle down in twenty-five minutes through $\frac{1}{16}$in. of water, which will then be quite clear, whereas it takes eight hours to clear 20in. of water charged with this precipitate. The rate of settlement is about 1·8in. to 2·5in. per hour. No experiments seem to have been made on hot water.

It is thus understood why very large tanks are necessary when working with cold water, and why even filters will not remove all the precipitated carbonate of lime.

When the softening operation is carried out hot, these settling tanks, as can be seen by comparing various softeners, may be much reduced in size, and filters now become far more effective than before.

In most of the cold-water softeners the treated water moves upwards against the descending sediment, which, being coarse, assists the newly-formed precipitate in settling down. In other softeners, notably in that of Desrumaux, the treated water is made to travel in comparatively thin sheets. Thus, by dividing the tower into narrow layers the precipitate has not to fall very far. This principle may be carried too far, for the thinner and longer the sheet of water, the greater the velocity and the stronger the eddies.

In spite of the use of very large settling tanks, supplemented by filters, there are very few cold-water softeners which can be relied upon to remove all the solid matter which the added chemicals have precipitated, and serious complaints are not infrequently heard that after the installation of a water softener, the injectors or the feed pipes get choked with scale. Evidently all the chemical precipitates do not settle down thoroughly until the comparatively hot pipes are reached.

To overcome this difficulty the Archbutt-Deeley process is arranged so that the carbonic acid gas from a stove comes in contact with the treated water and dissolves the trace of precipitate which would have appeared in the pipes. Steam users, however, have a prejudice against deliberately introducing carbonic acid into their boilers, and some at least add very large settling tanks, and do not use the stove. Unquestionably the most effective way of removing the residual precipitate would be to heat the treated water, but as already shown, that is a very expensive remedy.

In practice magnesia precipitates are still more difficult to deal with than the lime precipitates, because of their gelatinous nature, which, although it assists in separating out the carbonate of lime, also retards the settling process, and seriously interferes with the working of filters. Here, again, heat is a remedy, but only a partial one, and is very costly. Nevertheless, several of the softeners dealt with in this paper seem to have removed large quantities of magnesia without choking their filters.

In the Archbutt-Deeley softener, which, due to a sufficiency of lime, has effectively removed nearly all magnesia salts, each new tankful of treated water is mixed with the sediment of the previously treated waters, the settlement being expedited by the adhesion of the old and coarse particles to the new flocculent and gelatinous precipitates. The same principle is adopted in those softeners in which the treated water is led to the bottoms of the settling tanks, and has to pass through previously precipitated mud. Use is also made of the precipitated mud for the removal of grease in the apparatus of Babcock and Wilcox, Boby, Maxim, and Wollaston, in which exhaust steam is introduced. The explanation of the cause of this removal is doubtless to be found in the coagulation of the first-formed colloidal precipitate, which on separating effectively removes both the oil in suspension and in the emulsified state. Wollaston finds that the greasy scum rises upwards, and at the top of his reaction tower a scum tap is fitted, and the exit from this tower to the settling tank is placed some distance below, thereby preventing this scum from contaminating the softened water.

Out of seventeen continuous water softeners dealt with in this paper, fourteen are fitted with filters. Two of these, Bell's and Reisert's, are sand filters. Porter-Clark and Atkins have cloth filters, and the others have wood wool or sponge filters. Wood wool is cheap and can be renewed, say, twice a year, while sponges have to be cleaned. These removal or cleaning operations are rather tedious, but cannot be entirely obviated. Those filters through which the water passes downward, and on to which the sediment falls, have, of course, to be cleaned much more frequently than those through which the water passes upward.

Cloth filters have to be cleaned by hand. They generally consist of a number of wooden or iron frames, each frame being separated from its neighbour by a piece of cloth. The frames are pressed together by two long bolts. The water enters every alternate frame through a hole in the top side or middle, and is discharged out of holes in the bottoms of the adjoining frames. The cloths are easily removed by slacking back the nuts on the long bolts. The Atkins filters are circular discs which are brushed clean without removing them.

(To be continued.)

THE INSTITUTION OF CIVIL ENGINEERS.

At a meeting of students held at the Institution on Friday evening, the 18th instant, at 8 p.m., Mr. W. H. Wheeler, M. Inst. C.E., in the chair, a paper on "The Action of the Sea upon the Foreshore" was read by Mr. C. B. Case, Stud. Inst. C.E., and a paper on "The Causes of the Loss of Beaches, and an Outline of Coast Defence," by Mr. F. W. Cable, Stud. Inst. C.E. The following are the abstracts of the papers:—

"THE ACTION OF THE SEA UPON THE FORESHORE."

By Cecil Bertram Case, Stud. Inst. C.E.

In this paper the author describes the difficulties in the way of tracing the origin of phenomena resulting from the action of the sea, and classifies the forces which are chiefly instrumental in producing them. Distinction is made between foreshores which are susceptible to sea action, and those of an opposite character; and the investigation is devoted chiefly to foreshores of the former kind, the action of waves and of currents being, as far as possible, dealt with separately.

The influence of wave-action upon the angle of repose of shore material is described, showing how the angle of repose differs according to the shape and disposition of the shore particles situated in the course of the receding water, and how the angle is sometimes affected by the frequency of the "breakers." The motion of individual particles, and of a mass of particles, under the influence of waves striking the coast normally or obliquely, and the effect on this motion of the shape and buoyancy of the particles are investigated.

Reference is made to the effects produced by intercepting material drifting along the coast, and an explanation of the accumulation at Dungeness is offered. The manner in which high groynes intercept drifting material, and the consequences of the interception, are indicated. The action of waves upon upright sea-walls, and upon those prolonged seawards by an apron, is described; and steep and gently-sloping aprons are compared in respect of their effects upon the foreshore. The manner in which a scouring sea-wall hastens its own destruction is explained, and conclusions are drawn as to the correct form for a sea-wall.

The action of currents is investigated, distinction being made between tidal currents and wind-raised currents, and various ways in which material may be distributed by current action are indicated. It is also shown how current action interferes with wave action, by scouring out channels on the foreshore.

A comparison is drawn between those methods of sea defence which entail the erection of massive structures and those which can be worked out by the use of comparatively slender structures. The effects resulting from landslips upon the foreshore are also described. Reference is made to the large expenditure incurred in the defence of our coasts from sea encroachment, it being shown that much of it is frequently misapplied; and conclusion is drawn to the main principle to be observed in sea defence schemes.

"THE CAUSES OF THE LOSS OF BEACHES, AND AN OUTLINE OF COAST DEFENCE."

By Frederic William Cable, Stud. Inst. C.E.

The most important part of a scheme for the defence of the coast against the action of the sea is that which is designed to protect the foreshore. The foreshore is acted upon by the waves, which suck the shingle downwards in such a way as to form a small bank near low-water level. Meanwhile the tidal currents are carrying away the sand and other light materials which compose the bed of the sea, and eventually the bank of shingle becomes undermined and falls into the sea. In the case of the East Coast of England the sand and light materials are carried towards the Straits of Dover, the tidal currents flowing from north to south. The same action is in progress along the South Coast, where the tidal currents flow from west to east; and thus the material becomes deposited in the Straits of Dover, where the two tides meet.

There is no way of completely stopping the loss of beaches; but by means of groynes the destructive forces may be so controlled as to considerably modify or diminish their effect. The longer the groynes are made, at any place, the slower will be the alteration of the coast-line.

Sea walls should be either built for the reflection of the waves or for gradually diminishing their force. A wall for reflecting the waves should present an almost perpendicular front to the sea; but if the slope of the foreshore be such as to necessitate the latter form of wall, this should have a gradually sloping face towards the sea, which will destroy the force of the waves by causing them to act up an incline.

The reading of the paper was followed by a discussion, in which Messrs. E. M. Bull, H. O. H. Etheridge, H. W. FitzSimons, O. F. Parker, H. E. Steinberg, J. W. M. Topley, and S. M. Udale, Studs. Inst. C.E., took part.

Electric Light in the Faroe Islands.—It is suggested that Thorshavn, in the Faroe Islands, should be provided with electric light. According to the *Electrical World*, the water power is abundant for nine months of the year, and during that period it is so dark that artificial light is necessary. Petroleum lamps are generally used in the shops and houses and for street lighting; this could all be advantageously replaced by electric lighting during the season that lights are most needed. During the months of May, June, and July, when the streams are lowest, no lights would be needed, as it is daylight constantly.

Naval Engineer Appointments.—The following appointments have been made at the Admiralty:—Engineer Commander: C. A. Moore, to the Fire Queen, for the Sultan; W. Hines, to the King Alfred; J. S. Watch, to the Glory; J. L. Mitchell, to the Pembroke, for the Repulse; J. T. Willoughby, to the Euryalus; J. W. Agnew, to the Resolution; C. J. James, to the Enchantress. Engineer Lieutenants: F. R. Lister, to the Formidable, appointment to the Bacchante cancelled; J. T. H. Ward, appointment to the Formidable cancelled; J. S. Constable, to the Fire Queen; O. R. Paul, to the Fire Queen, for charge of gunboats; H. W. Harris, to the Fire Queen, for the Brilliant; T. B. Haddy, to the Vivid, for the Blonde; C. Pascoe, to the Mars; E. W. Chamberlain, to the Northampton, for the Cleopatra; A. Brown, to the Warrior, for the Dove; H. G. Summerford, to the Pembroke, for the Circe; A. E Collins, to the Fire Queen, for the Melpomene; P. H. Meynell, to the Pembroke, for the Prince of Wales; J. F. Bushby, to the Fire Queen, for the Andromeda; H. S. Morley, to the Fire Queen, for the Invincible; J. M. Murray, to the Vivid, for the King Edward VII.; W. S. Stevens, to the Pioneer; W. G. Colquhoun, to the King Alfred; F. G. Haddy, to the Glory; C. Main, to the Ocean; P. D. Church, to the Pembroke for the Gleaner; H. J. Meiklejohn, to the Vindictive; F. D. Thomsett and J. H. Hocken, to the Swiftsure; G. G. Knight and A. W. Maconochie, to the Triumph; R. W. Toman, to the Northampton; J. A. Anderson, to the Audacious for the Greyhound; and C. Broadbent, to the Spartan. Engineer Sub-Lieutenants: B. C. Bowler, to the Edgar; C. L. Warren, to the Pembroke for the Hecla; and R. D. Cox, for the Pioneer.

Trevethick and Steam Power.—Reference to Trevethick and his experiment of 1808, as given in The Engineer last week, reminds a correspondent of a still earlier trial in 1804. This occurred in Wales in February of that year, and was duly published in the Cambrian newspaper, Swansea, of that period, and was afterwards referred to in the *Mechanics' Magazine*. The trial took place at Penydarran, Merthyr, and was the outcome of a bet between two ironmasters—Richard Crawshay, the founder of Cyfarthfa, and Homfray, of Penydarran Works. Trevethick, it appears, had made himself known as an ingenious man to Homfray, and that worthy entered into a bet with Crawshay that Trevethick would convey a load of bar iron from the works to the navigation, nine miles distant. The day came, February 12th, and, in the presence of an immense crowd, the engine was brought forth to view, the work of Trevethick, aided by Rees Jones, engineer, of Penydarran. The engine is described as a curiosity. It had a tall chimney stack, made of bricks, with a dwarf body, perched on a high framework, with large wheels; the cylinder was upright, and the piston worked downwards. Attached to the engine were trams laden with 10 tons of iron bar, and seventy persons. At a fixed hour the signal was given, a jet of steam burst forth, and with a great clang the wheels revolved, and slowly the mass moved along the track until a bridge over the line was reached, when away went bridge and stack. But Trevethick was a man of resource, and very soon the stack was built up again, and the terminus was reached, Homfray winning his bet. The rate of speed was given as five miles an hour. It was regarded as settling the possibility of locomotion, but the historian added that on account of curves and gradients it failed to bring the empty trams back, and thus the practical working of the engine for transport was left a question open for a future day

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(From our own Correspondent.)

THERE is very little additional to what was in last issue reported to say about the Birmingham and district iron trade at time of writing. The Christmas holidays are as I pen these lines close upon us, and new business is therefore practically nil, nor will any more be transacted until after the New Year has come in. It is, however, good news to learn that the Electric Construction Company have recently been booking some good orders of a general character, and that within the past fortnight they have received an important contract upon Admiralty account.

The arrangements for the extensions at the Wolverhampton works of Messrs. Bayliss, Jones and Bayliss are proceeding satisfactorily, and they appear to have given up their idea, for the present at any rate, of removing to the coast.

Other branches of the engineering trades are moderately engaged. Quotations for iron and steel are not at date being offered, as there are no buyers nor inquiries, but it is understood that were anything stirring, the figures that would be mentioned in answer to queries would be about the same as those ruling in the last fortnight, or possibly a shade lower.

The Christmas holidays will be about as long as usual, there being no reason to curtail them owing to pressure of work, as is sometimes the case. Mr. E. Sandeman, the chief engineer to the Water Board, is evidently making good progress with the Derwent Valley scheme, involving an outlay of seven millions sterling, which will do so much to improve the water supply of Leicester, Sheffield, Derby, and Nottingham. At Howden trouble has been caused by a geological fault, and by water consequently getting into the workings. Numerous streams of water flow into the bottom of a trench, the estimated daily total being 750,000 gallons; and to cope with this inrush vigorous pumping operations are carried on without cessation. Two Tangye pumps, driven by powerful engines, and also a Pulsometer pump, force the water over the side of the trench and into the river, and the navvies are thus enabled to continue their work without interruption. Midland trade interests are well represented upon Mr. Chamberlain's new Tariff Commission, whose members, it is noted locally with pleasure, include Sir Alfred Hickman, Sir Alexander Henderson, M.P. for the Western Division of Staffordshire; and Mr. Arthur Keen, of Guest, Keen and Nettlefold's, and other companies. The secretary, Professor W. A. S. Hewins, is a native of Wolverhampton, and received his earlier education at the Wolverhampton Grammar School. He was recently director of the London School of Economics, and Professor of Economic Science and Statistics at King's College. He is one of the cleverest of European economic experts, and in his work as secretary he will be assisted by a staff of specialists, and of statisticians, and indexers.

NOTES FROM LANCASHIRE.

(From our own Correspondent.)

Barrow.—There is a still quieter demand for hematite pig iron this week, and at Barrow four furnaces have been damped down, and a similar number at Workington, in consequence of the stoppage of the steel mills for the holidays and the inadvisability of producing pig iron for which there is no demand, and especially in view of the fact that stocks are so large already. There are now only fifteen furnaces in blast, one having been damped down at Millom, compared with thirty-three in the corresponding week of last year. It is expected that a furnace will be damped down at Ulverston, and another at Carnforth. The iron trade has not been so quiet for many years; indeed, there never were fewer furnaces in blast, except when the Durham strike was on, and when coke supplies were short. Makers are quoting 54s. 6d. normal net f.o.b. for mixed Bessemer numbers. Warrant iron, 52s. 4d. net cash sellers, buyers 4d. less. Warrant stocks stand at 12,533 tons, and makers hold stocks approximating 175,000 tons. One furnace is still on charcoal iron, for which there is a good demand.

Iron ore is exceedingly quiet, and at most of the mines fewer men are employed. Very few men are now working at the Mouzell mines, and the men employed at the Lindal Moor mines, the oldest mines in Furness, have had a fortnight's notice given them, in view of the closing of the mines and the liquidation and, it is hoped, reconstruction of the company. The mines at one time produced the richest ores in the district, but latterly the deposit has been reduced considerably, and no new finds of importance have been made. There is great difficulty in the working of these pits in consequence of the great volume of water which has to be pumped. Ordinary qualities of ore are quoted at 9s. to 9s. 6d. per ton net at mines.

Steelmakers have stopped their mills, at any rate for a fortnight. It all depends on the inflow of orders as to when they will resume operations. A few orders are held for rails, but they will not provide full activity, and there is still keen competition for the orders in the market from German and Belgian firms. A quiet market is reported for shipbuilding material, and orders are indifferently held.

In shipbuilding the only news is the reported order for a small cruiser of 700 tons to be built by Vickers, Sons and Maxim for the Canadian Government, for the purpose of protecting the Canadian fisheries.

Engineers, ironfounders, and boilermakers are passing through a very quiet time. Orders are scarce, and employment is erratic and irregular.

The coal and coke trades are depressed. There is a smaller consumption of fuel of all sorts, and prices are showing weakness both as regards steam coal and blast furnace coke.

In the shipping trade business is very quiet, and exports show a marked decline. They now total up to over 100,000 tons less than in the corresponding period of last year.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

THE work of the year has practically ended. Very little is now done when the third week of December is reached, and this season much less than usual, owing to the depression which unfortunately prevails in nearly all departments of trade, both light and heavy. In the coal industry the year closes with rather firmer tone in household fuel, owing to the uncertain state of the weather, cold snaps succeeded by fogs and rain in between. Heavy tonnages have recently left the district for the metropolis and several of the provincial markets. Local sales having also been satisfactory, values have been easily maintained. Best Silkstone sells at varying rates up to 13s. per ton; Barnsley house, in which the largest business is done, fetches 11s. 6d. to 11s. 9d.; seconds, from 10s. 6d. per ton. These figures show a considerable falling off as compared with the rates at the corresponding period of last year, except in the inferior qualities.

Steam coal, of course, is now a diminishing quantity for export purposes, on account of the closing of several of the foreign ports, and there is no briskness in the home demand to compensate for the lessened call from abroad. Considering the season of the year, however, the volume of trade done cannot be regarded as unsatisfactory. Although the business for November and so far in December shows a decrease, the aggregate of the year is in excess of that for 1902. The contract price of 9s. per ton is still exceeded for supplies bought in the open market, where buyers have to pay from 3d. to 6d. per ton more. For slacks the request if still active, owing to the requirements of Lancashire, where the textile trades are doing better than iron and steel. The Lancashire demand is chiefly for the better qualities, inferior sorts being very weak in that and other markets, and values consequently low.

No improvement can be reported in coke. In the best sorts 11s. to 11s. 6d. per ton is obtained, and there is little demand at these figures, which exhibit a weakening of values as compared with the closing month of 1902.

The steam coal contracts for next year are being considered, but nothing has yet been done. Several consumers make a point of coming to terms as soon as possible, and in their case arrangements may already be regarded as good as fixed; but the coalowners, as a body, act together, and though the season is far advanced, we cannot hear of anything being yet generally arranged. The coalowners, of course, are anxious to secure an advance on last year's rates, but it may be doubted if they will succeed. Most people conversant with the coal trade anticipate that this year's rates will rule in 1904.

In the iron and steel industries the outlook is anything but satisfactory. Many principals state that they have not known in all their long experience a year terminate with their order book so light. All hope of fresh armour plate orders being placed this year was abandoned some time ago, although the member for Brightside—where the work is done—expressed himself hopefully on that score. It will be a welcome feature of the new year if early in January the Admiralty are in a position to give a definite reply to the tenders which went in six weeks ago. The depression in the armour mills and the heavy industries generally has caused much distress at the East End of Sheffield, and the relief fund opened by the Lord Mayor, which now considerably exceeds £2000, is likely to be urgently called upon. Distribution, in fact, is already taking place to the needier people.

There is no better report to be given of the lighter industries. One or two firms do not complain much, but the general condition of the cutlery, silver, and plated trades is far from satisfactory. When the works close on Christmas Eve the artisans will have holidays protracted beyond their desires. The demand from the home market, in the metropolis, as well as in the provinces, has been exceptionally quiet. Travellers report that they have rarely experienced a time when there has been so much difficulty in collecting accounts. Some important Government contracts placed for razors have been an acceptable feature of recent developments, but, generally, the cutlery trade is in a very dull state, with no immediate prospect of any improvement. Some kinds of edge tools are in demand, and mining and excavating tools are being ordered in considerable quantities.

The holidays in Sheffield will begin on the 24th inst., and work will not be resumed anywhere before January 4th, 1904. In some trades there is talk of a very long holiday, extending, we hear, into weeks, but we think there may be no need to "shut down" for so long a period as that.

The funeral of Mr. Edward Cowey, for many years President of the Yorkshire Miners' Association, took place on Sunday afternoon at Shackleton Cemetery, near Barnsley. Shackleton is the village where Mr. Cowey for many years officiated as the miners' checkweighman. There was a very large attendance of miners' officials and the mining classes generally. The Rev. S. C. Walley, rector of Kirkthorpe, officiated at the graveside, and in an address in Sharlston Church bore testimony to the high character and honourable career of the deceased.

The Barnsley seam of coal was reached at Silverwood, near Rotherham, it seems, in less time than reported last week. The sinking was commenced by the Dalton Main Collieries, Limited, in the spring of 1900, and the seam was tapped last week. The Barnsley bed has been proved at a depth of 740 yards, and is of excellent quality, the hard steam portion of the seam being 3ft. 10in. thick, with a total thickness of about 5ft. 9in. The workings from the old Roundwood colliery are already within a short distance of the new shaft, and will soon be connected with it. The plant is laid out to deal with an output, if necessary, of 5000 tons of coal per day, and screens capable of passing this quantity, together with requisite washery, are also in process of erection.

NORTH OF ENGLAND.

(From our own Correspondent.)

NATURALLY there is not much disposition among consumers of pig iron to buy this week, but a few days ago there sprang up a considerable inquiry for Cleveland pig iron for delivery over the first half of next year. At first the buyers offered 3d. less than they would give for prompt delivery, or 41s. 6d. for No. 3 G.M.B., but makers did not see their way to accept that, and then 42s. became the forward price, that also not finding favour with the producers, who do not entertain so pessimistic a view of the prospects of the next half-year as many are inclined to hold. They will not commit themselves more than a few weeks ahead, as they expect to realise better prices in February. What strengthens the position of the producers in this district is the fact that they are not letting the output exceed the consumption to any material extent, as is apparent from the fact that, while the shipments have this month fallen much below what they were last month, the stocks are not increasing either at the works or in the public warrant stores. This is because the make has been reduced to the same extent as the demand. This is advantageous in more ways than one, for it checks the fall in the selling prices of the pig iron, while it brings down the cost of production in so far that the lessened demand for coke leads to an easing in the value thereof. The price of coke, however, has not declined to the extent that might have been expected, because the coke manufacturers are themselves restricting the production, and a large number of ovens have been put out recently, so that it cannot yet be said that coke is relatively as cheap as Cleveland pig iron, and certainly it relatively is considerably above what can be realised for either East or West Coast hematite pig iron, notwithstanding that the make in both districts has been much reduced.

The exports of pig iron from the Cleveland district this month have been so far about 35 per cent. less than those of November, the shipments oversea being quite 50 per cent. less, but Connal's stocks have only increased 410 tons, because so much less pig iron is made. Altogether five furnaces in this district have been blown out within the last month.

The quotation for No. 3 Cleveland G.M.B. pig iron nearly all the month has been at 41s. 9d. per ton for early f.o.b. delivery, and that steadiness has rather tended to induce consumers to offer to buy for forward delivery. The prices of Cleveland iron are firmer now than they usually are in December, but they do not improve as they did in the last month of 1902, for there is not the demand on export account which was reported then, and America, which in that month took 42,000 tons of pig iron from Cleveland, this month has not needed a ton. No. 1 is at 42s. 9d., No. 4 foundry at 41s. 6d., grey forge 41s. 3d., mottled 41s., and white 40s. 9d. per ton, practically the same figures as ruled last week.

The twelve o'clock Saturday question at the Cleveland ironstone mines is being agitated by the miners. The employers are asked to make the concession that a certain section of the workmen shall be allowed to leave work at 12 o'clock on Saturdays instead of one o'clock. That is the rule at the Durham collieries and at most of the works. The employers do not, however, see their way to make such a change, as it is necessary that the supply of ironstone should be kept up for the ironworks at the week ends. Enough ironstone has to be sent away on Saturday to tide the ironmasters over the Sunday and a good part of Monday. The men have urged that the concession would not interfere with the quantity of stone delivered to the works. At the same time the employers contend that the change would be attended by an increase of cost.

Some improvement can be reported in the hematite pig iron trade, though the prospect for next year is gloomy, not only here, but on the West Coast. The ironmasters in the latter district are taking even more drastic measures than those in the North-East of England for bringing the supply down to the level of the demand, and a greater proportion of the furnaces have been put out or damped down. There, if the business in hematite is slack, furnaces have to cease operations; in this district, on the other hand, some of the furnaces which have ceased to make hematite iron have not gone out, but have commenced to produce ordinary Cleveland or basic iron. Iron merchants and coke manufacturers in this district who supply ore and fuel to Messrs. Cammell and Co.'s furnaces in the Workington district have received notice that all their furnaces are to be damped down till March next. Of the eight furnaces at their two works six have been in operation. In this district Messrs. Bolckow, Vaughan and Co., who were at one time the largest makers of hematite iron in the North of England, have ceased the manufacture, as they have also of steel plates, until trade improves and they can produce these at a profit. Mixed numbers of East Coast hematite pig iron at the close of last week were obtainable at 50s. per ton, which was 8s. per ton below the price ruling in April, that being the best figure of the year. Nothing so low as 50s. has been known for more than five years. But this week the quotation is up to 50s. 6d., the reduction of production having influenced the market upwards. Very little that is favourable can be reported, business being extraordinarily dull in nearly all branches of manufactured iron and steel, and the holidays will make little difference in the production, for most works have had some holiday every week for a long time past. The plate makers, who reduced their prices 2s. 6d. per ton so recently as the last week in November, have found it necessary to bring them down another 2s. 6d., and they are now asking £5 7s. 6d. less 2½ per cent., the top price of the year being £6 less 2½ per cent. Not since January, 1898, has such a low price ruled, and it is £3 per ton less than was quoted in May, 1900, when the top price of the late boom was realised. In September, 1896, £4 17s. 6d. less 2½ per cent. was quoted, that being the lowest price on record. Iron plates have not been altered. Under such circumstances the steel manufacturers of the North of England and Scotland have claimed from the melters a reduction of 5 per cent., the last reduction being made in the spring of 1901, when selling prices were a good deal above those at present ruling, and they should have no difficulty in getting the wages down. Steel ship angles are at £5 less 2½ per cent., and iron ship angles at £6 less 2½ per cent. Common iron bars are at £6 2s. 6d. less 2½ per cent. Heavy steel rails are firm at £5 net at works, and a fair business is being done in them, as has been the case all the year.

At the Central Marine Engine Works, West Hartlepool, during 1903 sixteen sets of machinery have been turned out of an aggregate indicated horse-power of 21,920, as compared with eighteen sets of 25,000 indicated horse-power in 1902. The whole of the machinery was of the triple-expansion type, and fifteen were for steamers, while one set was for the electric-power plant now being installed at the works. The boiler department has built thirty-seven boilers, six being for renewals in old steamers. The firm has made further progress in introducing the Borrowman patent superheating apparatus to the boilers of ordinary cargo steamers. Messrs. Richardsons, Westgarth and Co., Limited, have, in 1903, fitted engines to 36 screw steamers, among them the twin-screw steamer Everton Grange. The total indicated horse-power of the engines which they turned out, including marine engines, gas engines, electric-power engines, steam blowing engines, boilers, &c., was 82,600.

The Education Committee of the North-East Coast Institution of Engineers and Shipbuilders has drawn up a most important report on the question of the training of apprentices. They—the Committee—believe that the industrial conditions of the country call for some change in the methods of selecting and training those destined to work in the higher branches of engineering and shipbuilding, and they have drawn up regulations for adoption in works. The apprentices should be divided into "ordinary apprentices," and "pupils." Of the latter, there might be six, on the average, at a time. They are to have a three years' college course before going into the works for three years, or they may combine workshop experience and college study for six years. Ordinary apprentices are to have rewards for time-keeping and good conduct, and for passing approved examinations. Something of the latter arrangement has already been adopted by Messrs. Richardsons, Westgarth and Co., Limited, and several other firms, including Palmer's Shipbuilding and Iron Company, and Messrs. Clarke, Chapman and Co., have the arrangement in force in respect to the other portion of the scheme, and they are found to work very satisfactorily.

The coal trade is slacker than it has been for a long time, and a good many of the collieries have worked badly, comparatively few indeed being run full time, except those turning out gas coals; prices accordingly are weak, more especially those for steam coal. Best coke maintains its value fairly well, because of the activity at the iron foundries, and 15s. to 15s. 6d. f.o.b. can be realised for it; but medium coke, which is what is chiefly consumed at the blast furnaces is decidedly tending downward in value, because the consumption has fallen off by reason of the blowing and damping down of furnaces in this district and on the West Coast, which latter district also procures its supplies of coke mainly from Durham county. The coke manufacturers have reduced the production by putting out ovens, but nevertheless consumers have been able to buy it at 13s. 9d. per ton delivered at the furnaces on Teesside, though 14s. is the general quotation.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

THERE has been comparatively little doing in the pig iron warrant market in the last few days. Consumers of iron appear quite indifferent, the holidays being here, and there being little or no chance of prices going up materially before fresh supplies of raw iron are likely to be required.

Cleveland warrants have been done at 41s. 6½d. to 41s. 6d. cash, but there has been no business either in Scotch or Cumberland hematite warrants.

The demand for Scotch hematite pigs at the moment is slow, and prices have been further reduced 6d. per ton, merchants quoting 55s. 6d. for delivery at the West of Scotland steel works.

Since last report one furnace that was making ordinary iron at Dalmellington has been put out of blast. There are now eighty-five furnaces in operation in Scotland, compared with eighty-seven at this time last year.

Prices of Scotch makers' pigs are in some cases quoted 6d. to 1s. lower. Monkland, No. 1, is quoted at Glasgow 50s. 6d., No. 3, 49s; Carnbroe, No. 1, 51s., No. 3, 49s.; Clyde, No. 1, 58s. 6d., No. 3, 51s. 6d.; Gartsherrie, No. 1, 59s., No. 3, 52s.; Summerlee, No. 1, 60s., No. 3, 52s. 6d.; Langloan, No. 1, 70s. 6d., No. 3, 56s. 6d.; Coltness, No. 1, 71s., No. 3, 55s. 6d.; Glengarnock at Ardrossan, No. 1, 59s.; No. 3, 51s.; Eglinton at Ardrossan or Troon, No. 1, 52s., No. 3, 49s.; Dalmellington at Ayr, No. 1, 51s. 6d., No. 3, 48s. 6d.; Shotts at Leith, No. 1, 61s. 6d., No. 3, 55s. 6d.; Carron at Grangemouth, No. 1, 62s. 6d.; No. 3, 55s. 6d. per ton.

The shipments of pig iron from Scottish ports in the past week reached 4108 tons, against 5352 tons in the corresponding week of last year. The total shipments for the year to date are now 308,048 tons, being 51,520 tons less than in 1902.

The arrivals of Cleveland pigs at Grangemouth amounted to 9104 tons, an increase of 996 tons over those of the corresponding week; while the total arrivals for the year to date have reached 568,078 tons, showing the large increase this year of 88,522 tons.

In the finished iron department there is a quiet business, and

the outlook has only moderate encouragement for makers, who are anxious as to how they will keep their works employed. The home branch of the trade has been fairly good, but competition for shipping orders is very keen.

The steel trade is at the moment in a somewhat doubtful position. A strong effort has been made by the makers to arrive at an understanding as to selling prices, so as to put an end to underselling, which for some time has been gradually reducing values. It has been agreed to quote steel ship plates at £5 10s., boiler plates £6, bars and tees £6, and angles £5 per ton, all less the usual 5 per cent. discount. Whether it will be possible to maintain these rates remains to be seen. Business has lately been reported at from 5s. to 15s. per ton lower, and it is well known that merchants have sold rather heavily below those now fixed by makers. The competing English prices are about the same as those now agreed upon by the Scotch makers. When trade is slack and orders difficult to obtain, as has lately been the case, it becomes a very difficult matter to maintain uniform rates. It may be a question, too, as to whether shipbuilding orders may not to some extent be kept back by the rates just fixed. A number of fresh shipbuilding contracts have been intimated within the last few days, but the material for them was no doubt secured before the orders were publicly mentioned.

As regards the iron-founding branch, it is understood that large pipe makers are pretty well supplied with work. The tube trade is, however, passing through a time of depression. The locomotive engineering works are in some cases busy, this being the case as regards the independent companies. The railway shops, on the other hand, have encountered a time of slackness, and the workmen have been informed that the New Year holidays are to be prolonged in some cases to the extent of three or four weeks, this being considered a better plan than resorting to short time immediately after the holidays, a course which seemed to be the only alternative to that about to be adopted.

There is no change of any importance to note this week in the position of the coal trade. As was to be expected, a marked contraction is taking place in manufacturing orders. On the other hand, the household branch has been busy. There is only a moderate inquiry in the shipping department. Coal prices are generally without material alteration.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

THE subject of pitwood—which article of commerce is now, in consequence of the strike amongst the dock labourers of Bordeaux, up to 20s. the ton, a matter of grave consideration at the Welsh ports—was commented upon last week by a Cardiff merchant as follows:—"Contracts," he said, "have been entered upon for six months ahead, at prices varying from 17s. 6d. to 18s.; but rapid strides are being made at Lisbon and Oporto to supply needs, and French merchants have opened a branch at Lisbon with the idea of getting that market under their own control." On the whole, his impression was that easier prices would rule for wood to the Bristol Channel ports next year. Referring to the afforesting of Wales, he "thought it feasible, but it was a question of price." We were getting also good wood from Ireland. Formerly supplies came from Southampton from the New Forest, but these had ceased.

Towards the end of the week there was the usual rush in of tonnage to clear before the holiday season, and some cargoes of note were despatched both from Cardiff and Newport. From Cardiff 6300 tons of coal went to Hongkong, 5500 to Torre Annunziata, to Port Said one of 5000 tons, and another of 450; to Palermo 4800. Big shipments of patent fuel also went off at close of week, 5000 tons going to Singapore, 3700 tons to Vera Cruz, and 2500 to Pernambuco. Newport despatched some large cargoes—4300, 2500 tons, and a number of others.

The latest news at the Cardiff docks is that more large orders are being placed by agents for Russia, both for coal and patent fuel, for Port Arthur and Vladivostock. A local contemporary, referring to the cargoes sent away in October, states that they will arrive at their destination in a week or two. The run takes about sixty days. The leading feature of the freight market, Cardiff, at end of week was slackness for Mediterranean, with a little improvement towards the close. Bay freights better, and a fair demand for the Far East; rates varying from 20s. 6d. to 21s. patent fuel for Port Arthur.

Mr. Trice, shipping agent for the Tredegar Company, has been appointed shipping agent for the Ebbw Vale Company.

The impression amongst leading men in the coal trade is that prices will be easier as the new year opens. For a time prices may vary about the close of the year, due to special causes, but the tendency for steam coal prices is against high figures, unless war business crops up. There is at present a very large output going on, and the collection of coal trucks a few days ago from Newport to Barry, and again in the Swansea district, was unusually great. This is now being lessened, and if weather favours a good deal will be dispersed. The tone of the Cardiff market when the week opened was against alteration of figures, but for delivery at later dates than present week higher quotations. Closing prices, Cardiff:—Best steam, 14s. to 14s. 6d.; seconds, 13s. 3d. to 14s.; dry, 13s. 6d. to 13s. 9d.; best small, 7s. to 7s. 6d.; seconds, 5s. 9d. to 6s.; cheaper steam, as low as 5s. 3d. to 5s. 6d., including dry coals; Monmouthshire, semi-bituminous, 12s. 9d. to 13s.; best ordinaries, 12s. 3d. to 12s. 6d.; seconds, 11s. 3d. to 11s. 6d.; house coal, 16s. 6d. to 17s.; best ordinaries, 14s. to 15s.; seconds and other sorts, from 10s. 6d.; No. 3 Rhondda, 14s. 9d.; brush, 12s. to 12s. 3d.; small, 9s. 9d. to 10s.; No. 2 Rhondda, 11s. to 11s. 3d.; through and through, 8s. 6d. to 8s. 9d.; small, 6s. 6d. to 6s. 9d. Patent fuel, 14s. 6d., including tax. Coke, 17s. to 23s.; tendency easier. Pitwood, 18s. 6d. to 19s.; price fluctuating.

Swansea is quoting best steam at 14s. 6d.; seconds, 12s. 6d.; bunkers, 9s. 3d.; small, 6s. House coal in parts of district still depressed. Latest figures:—No. 3 Rhondda, 15s.; through, 12s. 6d.; small, 10s.; No. 2 Rhondda, 11s. 6d. Patent fuel, from 13s.; trade not brisk. Pitwood, 19s.

In the anthracite trade things have been quieter, on account chiefly of delayed tonnage, and prices drooped slightly. It is now thought that some portion of the great syndicate scheme will be carried out, but not the whole. Men well versed in the trade never expected that the original one would be found practicable, and that the only way to ensure success eventually would be to link properties in detail. The task was Herculean—to unite so many varied tracts belonging to different owners, each with different views, some tenures lengthy, others short, and the nature of coal varying even as much as the estimate of the holders. If a small compact syndicate see the light it will be as much as can be expected.

Latest prices are as follows:—Anthracite malting, 18s. to 20s.; big coal, 10s. to 11s.; machine made cobbles, 19s.; nuts, 19s. to 22s.; peas, 13s. 9d.; cubes, 5s. 6d.; duff, 3s. 6d.

It is hoped that an improvement will be manifested in iron and steel next year. At some works the situation has been met by giving partial work, and not resorting, as in North of England districts, to blowing out of furnaces. The practice of "lighting up" for a few days and then discontinuing will not, it is thought, be continued, but a reduced make will be arranged unless times alter. In the Swansea district the notices given at Landore by Messrs. Baldwin matured on Saturday. The intention, I hear, is not stoppage, but a rearrangement of wages. At Gomerton the steel smelters now work at a reduction of 10 per cent.; while the millmen concede a turn a week.

The artisans and steel workers in the Glamorgan and Monmouthshire districts are expected to concede 15 per cent. I believe if this will ensure more regular work it will be arranged.

Tin is fluctuating a good deal, and is slightly easier. Welsh tin-plates this week are being quoted in Liverpool at 11s. to 11s. 3d., prices firm, and are believed to have touched bottom.

Pig iron inactive. Spelter and lead firm. Llanelly is importing steel scrap from Chester, and pig from Ardrossan.

Large cargoes of iron ore from Bilbao and Castro came in last week to Newport for Ebbw Vale.

The reduction of Ebbw Vale capital has been sanctioned.

The Steel Smelters' Union accounts show a loss on the quarter of £3278 18s. 6½d., owing to the lockout in the trade.

The South Wales Miners' Federation issued a manifesto last week strongly enjoining members to oppose a renewal of the contracting out scheme either in its present or altered form, first, because it is wrong in principle; secondly, because the five years experience of the Compensation Act has been satisfactory, and for other reasons.

A general movement against the coal tax is understood to be preparing.

The Swansea spelter strike at the English Crown Works has been settled after lasting five weeks, the men accepting the owners' alternative terms. Sunday labour is to be continued, without extra pay, but overtime rates from 2d. to 4d. per day are to be conceded.

It is now definitely announced that on Wednesday the long-delayed opening of the Llanelly Harbour gates will take place. There is a good deal of pleasing excitement at the port in consequence.

London and North-Western engineers, I learn, have been making examination of the district between Swansea Valley and Pontardulais, and, though official information is lacking, it is assumed that the intention is the construction of a new line through Velindre to Gorseinion. This, a correspondent points out, would imply a competitive route to the one authorised by the Great Western Railway between Morriston and Pontardulais.

The Great Western and Newport Council are in correspondence about widening the railway bridge near Barrack Hill. The Council proposes to offer £1000 towards it.

NOTES FROM GERMANY.

(From our own Correspondent.)

THE meeting that was held on the 7th inst. for the purpose of finally settling the question of the steel convention has again led to no result; now all further negotiations have been postponed till February 29th next year. Old syndicates—such as the rail, girder, sleeper, and billet convention—would with the 31st of the present month have been prolonged, provisionally, till March 31st; in case, however, that an agreement concerning the steel convention could not be arrived at before February 29th, the works would be permitted to effect free sales from that day.

Business transactions on the iron market over here have again been of a limited description.

In Silesia pig iron continues in fairly good demand, and malleable iron has been moderately well inquired for upon the week. Also rails have been selling rather briskly. But there is still an exceedingly depressed condition reported in the plate and sheet trade, orders generally being very scarce, and those actually obtained fetch but low prices. It is hardly possible to give any definite prices just now, as so much depends on the weight of the order and also on the capacity of the works; competition is extraordinarily keen among the different establishments, so that in many instances the prices actually taken are much lower than those at first quoted.

A languid and somewhat hopeless tone pervades the iron industry of Rheinland-Westphalia, and as export has been rather decreasing, the reserve among consumers has been more marked than before. For crude iron a very poor demand only is forthcoming, and the malleable iron trade likewise has been getting more quiet from week to week. Also for finished iron a moderate inquiry comes in. A little more life was noticeable at some establishments, but, on the whole, manufacturers consider themselves fortunate if they can secure sufficient work to keep their concerns but moderately engaged. With regard to quotations, a weakening tendency was generally perceptible.

At a recent meeting of the Union of German Iron Foundries, it has been agreed upon that, owing to a lively demand, and to an increase in the costs of production, a rise in the prices of castings had become necessary.

The Railway Administration, Berlin, has been requested to negotiate with local shops that had hitherto executed orders for the Prussian Hessian Ludwigs Bahn, regarding the supply of further 161 locomotives of different types, so now the number of locomotives given out would amount to 606.

The coal trade in Silesia has been fairly active, deliveries being greater than in previous weeks. The coke market, too, is stated to be in a favourable condition.

The Rhenish-Westphalian coal trade is much as reported recently, a moderate business generally passing through. Gas coal is in brisk demand, and dry sorts of coal are likewise fairly animated. Blast furnace and foundry coke remain in steady request, and the business in briquettes is satisfactory.

In some branches of the Austro-Hungarian iron industry a slightly better trade was done during this week and the last, but this has not in any way influenced the general tone of the market. Crude iron remains quiet, and girders naturally are languid. Orders booked in bars reach up to end of first quarter in 1904. Also in the plate and sheet trade a moderately good business was done, and contracts for the first quarter next year have already been secured. The locomotive and wagon shops are going to be very actively employed on some rather heavy orders for the North-West Railway; eight express locomotives, eight goods train locomotives, fifty passenger cars, eight load wagons, sixty-five covered and twenty-eight uncovered load wagons will be required, total value being 3,000,000 crowns.

The coal trade in Austria-Hungary has been in a slightly better condition lately. Gas coal is in rising demand, and in the coke trade the increasing consumption for house-fire purposes makes up to a certain degree for the limited demand that comes in from the iron and steel departments.

Ironmasters in France are mostly doing but a moderate trade. In the Haute-Marne the business transacted upon the week was pretty lively, also the works of the Meurthe-et-Moselle department are in fair employment, but the general tone, nevertheless, is quiet, and even dull, and there is very little hope for improvement in the immediate future, even a further falling off generally in the demand for iron and steel being expected during winter.

The majority of the machine and wagon shops are weakly occupied, only the motor-car factories are actively engaged.

The French coal market maintains the former stiff tone, although, considering the time of the year, deliveries have been rather smaller than might be expected.

In Belgium the business done in iron and steel shows a decrease against previous weeks. On the whole, insufficient employment is rather less complained of than unremunerative prices. Not merely on home account, but also for foreign orders, concessions are willingly made to obtain orders. German, English, and French competition is very keen; also the United States offer freely in Belgium. There is talk of Government orders holding out. Prices for rails have considerably weakened of late.

For house coal an improvement in demand could be felt in Belgium, while engine fuel remains quiet as before.

AUSTRALIAN NOTES.

(From our own Correspondent.)

SOME time ago a Royal Commission was appointed by the Federal Government to investigate into the desirability of granting a bonus for the manufacture of iron and steel within the Commonwealth. Two reports of the findings have been presented to the Governor-General. One, signed by the chairman and five other members of the committee, which strongly favours the granting of a federal bonus; the other report, which is signed by five Oppositionist free traders and the Protectionist leader of the labour party, opposes the granting of a bonus to private individuals. The latter report is worded as follows:—"We are against the passage through Parliament of a Bill for the payment of bonuses by the Federal Government for the establishment of the iron industry within the Commonwealth. We recognise that the Commonwealth possesses vast deposits of iron ore of high grade, coal, &c., for ironworks. Ample evidence has been given to satisfy us on that point. Furthermore, we believe it would be a considerable advantage to have the industry in operation in a flourishing condition and on a proper basis. In our opinion, however, such a desirable result would not be best promoted by the Bill we have been asked to consider. The Bill provides for the payment of £324,000 of the people's money to private individuals engaged in enterprise for their private gain. There can be no guarantee that the bonuses proposed would permanently establish the industry, though it is probable the inducements offered might be instrumental in forming speculative companies. The evidence failed to show that there was any commercial necessity for the bonuses proposed."

In dealing with the evidence before the iron bonus commission, the following particulars were elicited:—

Iron and Steel Imported into the Commonwealth during the Year 1902.

	tons.		£
Pig iron	23,079	valued at	98,373
Bar and rod iron and steel	88,282	,,	334,636
Plate and sheet iron and steel	22,627	,,	178,548
Scrap iron	10,408	,,	32,907
Galvanised iron	44,538	,,	739,506
Steel rails		,,	391,822
Wire (plain)		,,	369,383
Wire (barbed)		,,	71,426
Wire netting		,,	135,160
Pipes		,,	298,183
Iron and steel machinery		,,	2,022,515

It is being continually advocated by interested parties that the laying down of plant for the production of pig iron and steel will be sufficient to supply the various classes of iron and steel manufacture now imported, overlooking the fact that each different classes of manufactures are specialities, and cannot be produced by one firm alone.

Railway engineers may be called upon to engage in peculiar varieties of work on occasions, but an appointment has recently been made in New South Wales that will be hard to beat—that is in the appointment of Mr. J. B. Sutter, a railway engineer on the New South Wales railways, to that of Commercial Agent in China and Japan for the State. This is a highly lucrative position, and was created by the Government to bring into closer commercial relations various countries with New South Wales, and to foster trade with that State. The other appointments that were made in this connection was one in South Africa, which was taken up by one of the principals of the leading agricultural colleges here, and the other at London, which was allotted to a well-known commercial man.

A phenomenal coal seam has just been discovered in the Newcastle coal district, New South Wales. Dr. Robertson, of the Caledonian Coal Company, has been advised that in the boring operations at Cessnock cut through a seam of coal 31ft. thick. The mine is to be opened up at once.

TRADE AND BUSINESS ANNOUNCEMENTS.

WE have received from Messrs. M. Glover and Co., Leeds, a glass paper weight, the object of which is to call the attention of the user to the patented "Ideal" saw guards and fire-lighting machinery made by this firm.

HENRY PELS AND CO. inform us that they have removed to new offices in Danes Inn House, 265, Strand, W.C.

NEW TYPE OF STEAMER.—Among the most notable types of steamers which have been launched this year is the s.s. Hedwig Heidmann, which has been built by Sir Raylton Dixon and Co., Limited, Cleveland Dockyards, Middlesbrough-on-Tees, to the order of Mr. H. W. Heidmann, of Altona, Hamburg, one of the principal coal merchants of the latter city. This vessel is built for carrying coals from the Scotch collieries on the Firth of Forth to Hamburg, and is especially adapted for this trade by many peculiarities of her construction and outfit. She is built to Harroway's patent, and the leading dimensions are:—Length over all, 300ft.; beam, 40ft. 6in.; depth, moulded, 22ft.; and she will carry about 3200 tons on a mean draught of 17ft. 4½in. The most remarkable feature about her is that for size of ship she will carry more water ballast than any other ship afloat, amounting in all to over 1400 tons, which is carried in such a position that she will be a remarkably easy ship in heavy weather, the propeller being always submerged in either light or loaded trim. The upper structure is so designed that the inner shell plating and frames are carried up to the deck on a diagonal line fore and aft, and a superstructure is built on this, containing the water ballast, carried to the side of the vessel, thus making her a very strong ship. The diagonal inner shell makes the vessel a complete self-trimmer, and the construction enables her to have exceptionally large hatches without interfering with her strength, and the double shell practically makes her unsinkable in case of collision. In outer appearance, and as to space on deck for dealing with the discharging of cargo and the working of the ship, she is the same as any ordinary vessel. The cargo holds have been so arranged that they are free from any obstruction such as beams and pillars, making her an ideal bulk cargo steamer. Five derrick masts are so arranged as to carry twelve derricks and gaffs. The most notable feature of the arrangements for discharging the coal consist of fourteen winches, six being ordinary and eight special whipping winches, worked by a continuous shafting along each side of the hatch coamings, with small drums at intervals, all worked by one compound condensing engine amidships, driving these shaftings at a high speed, and by means of the small whipping drums enabling fourteen gangs of men to whip the coal out of the holds in baskets and tip the contents of the same into barges alongside. These arrangements are calculated to discharge a cargo of over 3000 tons in eight hours. The vessel is also fitted with complete electric light installation for discharging purposes, so that the work of discharging can be carried on night and day. Engines having cylinders 20½, 34, and 56, by the North-Eastern Marine Engineering Company, Sunderland, are placed amidships, and are estimated to drive the vessel a speed of 10 knots. The most interesting point commercially is the fact that the net register in this type of vessel may be less than one-third of the deadweight—*i.e.*, the vessel will carry a 3200 deadweight cargo of coal on a net register of about 1000 tons, and this constitutes the lowest register of any description of full-decked ship. The vessel has been built to the highest class of Germanischer Lloyd under the inspection for the owners of Herr Stammell, of Hamburg. The launch took place on Saturday, the 19th inst., in the presence of a large number of interested spectators. On leaving the ways she was named Hedwig Heidmann by Mrs. John Heidmann, wife of the principal of the firm.

AMERICAN NOTES.

(From our own Correspondent.)

NEW YORK, December 9th.

WHAT is to be the largest tin-plate plant in the world is now being completed at Sharon, Pa., when the plans now under prosecution are carried out. The plant will consist of seventy pot mills, an increase of fifty over the present number. These mills will give employment to about 6000 men. This scheme involves the abandonment of the Muskegon tin mill, the Falcon Mill at Miles, Ohio, and two other plants. Economic conditions, involving cheaper fuel and advantages in gathering material, are the reasons.

The New England Foundrymen's Association holds its next regular meeting in Boston next week. One of the purposes of the meeting is to broaden the rule by which the fitness of pig iron for foundry use is to be determined, by the substitution of scientific analysis instead of the break test and rules-of-thumb methods which have been adhered to in all times past.

The railmakers of the United States will probably win in their vigorous contest to secure such reductions in freight rates from the mills to the Atlantic Coast as will enable them to secure larger orders abroad. The rate from Buffalo to New York is now 2·60 dols. per gross ton; from Johnstown to Boston 2·34 dols. The Lackawanna Steel Company is deeply interested. The Pennsylvania Company is interested in the great works at Johnstown, and will see to it that its interests are protected.

A representative of the United States Steel Corporation says there is no likelihood of a reduction in the price of steel rails at home, but it is not known what the price for export will be. It is intimated that the export price will be fixed at 22 dols.

The United States postal authorities, working in conjunction with the officers of the International Mercantile Marine Company, have lately made some changes intended to facilitate the transmission of the Transatlantic mails. The White Star Line steamships have been equipped with sea post-offices. The American lines' sailing day from this city has been changed from Wednesday to Saturday, as a result of the heavy Saturday mail, for Great Britain has had the advantage of transmission and the American line steamers which carry postal clerks, enabling letters to be sorted *en route*. In this way the mails have been delivered recently in the London Post-office in time for distribution on Saturday, instead of on the following Monday morning, as formerly. A large part of the British mail has gained from 30 to 36 hours in the time of delivery.

The recent reductions in export freight rates on steel products was followed last week by a cut in the export rates on grain. Next week the famous suit of the Government against the Northern Securities Company comes up in the U.S. Supreme Court. This is a very vital matter to those who have been making great railroad consolidations, as well as to those who have consolidations in view. No matter which way the decision goes, the railroad companies will be able to carry out their plans and schemes for greater consolidation.

A further decline in the foreign exchange market last week carried demand sterling down below the point established a few weeks ago. A good many bills came against London on the market. The purchase of securities and further offerings of bankers' bills were invited by the continued high rates for money. The total imports of gold under the recent importing movement has reached 1,400,000,000 dols.

The steel industry is feeling the effects of exhausted supplies among consumers, and there is a moderate increase in demand for all kinds of raw and finished material. Accumulated stocks have practically disappeared, and the market is therefore in a condition to feel the influences of incoming requirements. A large amount of business is in sight, but purchasers will continue to pursue for some little time yet the policy which they have been following for several months past. Steel rails will probably remain at 28 dols. for domestic requirements, while for export the price may be fixed somewhere between 20 dols. and 22 dols., although there is no certainty as yet as to what the final action may be.

LAUNCHES AND TRIAL TRIPS.

VERA, steel screw steamer; built by, Irvine's Shipbuilding and Dry Docks Company; to the order of, the Hessler Shipping Company, Limited; dimensions, 336ft. by 47ft. by 24ft. 10in.; engines, triple-expansion, 23½in., 38in., and 64in. by 42in., pressure 180 lb.; constructed by, Richardsons, Westgarth and Co., Limited; speed of 10¼ knots was attained; trial trip, December 16th.

DALTON, steel cargo steamer; built by, R. Craggs and Sons, Limited; to the order of, Messrs. Webster and Barraclough, of West Hartlepool; dimensions, 352ft., 47ft., by 27ft. 3in.; to carry, 6100 tons d.w.; engines, triple-expansion, 25in., 41in., and 67in., by 45in., pressure 180 lb.; constructed by, Blair and Co., Limited; launch, December 17th.

NESFIELD, steamship; built by, Joseph L. Thompson and Sons, Limited; to the order of, the Northfield Steamship Company, Limited, Liverpool; dimensions, 356ft., 48ft. 6in., by 27ft. 4in.; to carry, cargo; engines, triple-expansion, 25in., 42in., 68in., and 45in., pressure 180 lb.; constructed by, John Dickinson and Sons, Limited; launch, December 17th.

HAZELWOOD, steel screw steamer; built by, Ropner and Son, Stockton-on-Tees; to the order of, the Constantine and Pickering Steamship Company, Limited; dimensions, 336ft. 3in. by 48ft. by 24ft. 3in.; to carry, cargo; engines, triple-expansion, 1100 horse-power, pressure 160 lb.; constructed by, Blair and Company, Limited; launch, December 18th.

THE returns to hand relating to the Japanese Telegraphic Department show that at the close of last year Japan owned 29,898 miles of land wires and 4724 miles of submarine cable.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

☞ When inventions have been "communicated" the name and address of the communicating party are printed in italics.

8th December, 1903.

26,860. CHANGE-SPEED GEAR for MOTOR CARS, L. R. Jones, London.
26,861. SIGNS for ADVERTISING PURPOSES, J. Rosenberg, London.
26,862. INSTRUMENTS for DETERMINING the DEVIATION of MAGNETIC COMPASSES, A. Lietz, London.
26,863. TELEPHONIC RECORDER, S. Rowe, London.
26,864. PHOTOGRAPHIC MACHINES, E. de Pass.—(*P. V. W. Welsh and F. B. Waite, United States.*)
26 865. HANDLE-RENDING MACHINES, W. H. Johnson, London.
26 866. MEANS for CIRCULATING AIR, H. Taylor-Stephens, London.
26,867. MOWING MACHINES, R. H. Hutchinson, London.
26,868. GUNS, C. A. T. Sjögren, London.
26,869. EXPLOSION ENGINE, A. T. Collier, London.
26,870. HOLDERS for REFERENCE CARDS, H. G. Stewart, London.
26,871. IRONING MACHINES, W. E. Baker, London.
26,872. FRICTION CLUTCHES, A. Hérisson London.
26,873. AUTOMATIC TELEGRAPH APPARATUS, G. L. Hogan, London.
26,874. ROAD VEHICLES, J. M. Maclulich, London.
26,875. SCARF PINS, G. W. Dover, London.
26,876. SASH-BALANCING DEVICES, G. M. Scott, London.
26,877. HOISTING GEAR, A. Harrison, London.
26,878. CABLE STOPPER, W. E. Wynne, Grays, Essex.
26,879. COUPLINGS for RAILWAY VEHICLES, W. J. Carr, London.
26,880. BOOT and SHOE PROTECTORS, G. H. Hickson, London.
26,881. CUTTING MOUNTS for PICTURES, W. W. Izzard, London.
26,882. COUPLING HELICAL SPRINGS to STATIONARY OBJECTS, J. W. Bullock. Liverpool.
26,883. LAMPS, H. G. M'Haffie, Liverpool.
26,884. RESILIENT SUSPENSIONS for MOTOR CARS, W. R. Fasey, London.
26,885. TRANSPORTERS for BOTTLES, A. J. Boult.—(*P. Wagret, France.*)
26,886. TRANSMISSION MECHANISM for SELF-PROPELLED VEHICLES, A. G. Ionides, London.
26,887. MARKING SOAP, L. Z. Olsson, London.
26,888. WOVEN CARPET FABRICS, T. Daffin, London.
26,889. GAS FITTINGS, I. Shoob. London.
26,890. FLYING MACHINES, O. R. Richter, London.
26,891. PROTECTORS for BOOTS and SHOES, T. H. Dennis, London.
26,892. COMPRESSING WHEELS for PRESSES, W. A. Milne, London.
26,893. TUBULAR PEAT COLLECTORS, W. A. Milne, London.
26,894. TREATING LIQUIDS with OZONE, H. J. Rofe and and W. Elworthy, London.
26,895. STEAM GENERATORS, O. Imray.—(*The Stirling Company, United States.*)
26,896. OVENS for BAKING WAFFLE CAKES, Q. Crane, London.
26,897. DAMPING MACHINE BRUSHES, E. Moss and G. Paddock, London.
26,898. CHAINS for DRIVING VELOCIPEDES, A. and W. Hunnable and F. Mullis, Romford.
26,899. IMPREGNATION of POROUS SUBSTANCES. The Electric Timber-seasoning and Preservation Company, Limited, and J. H. West, London.
26,900. MANUFACTURE of INLAID WORK, C. Pfrimer, London.
26,901. CORSET FASTENERS, Theiler and Schneeli, London.
26,902. PULLEY FRAMES, S. E. Page.—(*J. Salomon, United States.*)
26,903. PAINT COMPOSITION, W. A. Hall, London.
26,904. PUMPS, T. Thompson, London.
26,905. MACHINES for FILLING CHARACTER DEPRESSIONS in BUTTONS, S. Thyberg and A. C. L. Chapman, London.
26,906. UMBRELLA SUPPORT, E. Cooke, London.
26,907. UNIONS, E. Cooke, London.

9th December, 1903.

26,908. BOLTS, T. P. Hughes, Birmingham.
26,909. MEANS for STRIKING MATCHES, E. Whitnear, Sheffield.
26,910. PIPE-CUTTING TOOLS, F. A. Headson, London.
26,911. TREATING ORES with CHLORINE, J. Swinburne, London.
26,912. INCANDESCENT ELECTRIC LAMPS, G. Davis, London.
26 913. TELEPHONE EXCHANGE SYSTEMS, J. Swinburne and G. H. Baillie, London.
26,914. ALCOVE PADLOCK, H. Mills and F. J. Stringer, Wolverhampton.
26,915. SWITCHES for ELECTRIC CIRCUITS, G. E. Fletcher, Manchester.
26,916. ADVERTISING on TRAMCARS, A. E. Walkden, Manchester.
26,917. INCANDESCENT GAS BURNERS, W. G. Potter, London.
26,918. INCANDESCENT BURNERS, W. G. Potter, London.
26,919. MANTLE SUPPORTS, W. G. Potter, London.
26,920. ECONOMISING APPARATUS for BEER PUMPS, G. Allinson and W. F. Hill. Sheffield
26,921. SLIP HOOKS for HARNESS, J. Trimmer, Southampton.
26,922. LAYING ELECTRIC CABLES, W. M. Rogerson, Halifax.
26,923. UPRIGHT BOILERS, R. Neilson, Glasgow.
26,924. DRIVING GEAR for CYCLES, D. Drysdale, Glasgow.
26,925. CARDING MACHINES, W. and A. Hamer, and J. B. Battye, Huddersfield.
26,926. STAND for BICYCLES, H. W. Bowman, Ashwell, near Baldock, Herts.
26,927. TURBINES, C. P. Horton, Birmingham.
26,928. COMBING COTTON FIBRES, J. Jolly and P. E. Willis, Manchester.
26,929. FASTENERS for the PICKER BANDS of LOOMS, T. Clark and Son, Limited, and H. Walmsley, Manchester.
26,930. CARPET SWEEPERS, J. Edsforth, Halifax.
26,931. SCREW STOPPERS, H. Akeroyd. Bradford.
26,932. CAST IRON PIPES, E. Bradley and W. H. Watkins, Hartlebury, Worcestershire.
26,933. EXPLOSION ENGINES, F. Lacey, Southampton.
26,934. MOTOR CARS, J. Endicott and T. Phillips, London.
26,935. AN ELECTRICAL CONTROLLER, D. E. Evans, Pencoed, S. Wales.
26,936. BRUSHES for WASHING BOTTLES, J. Watson, Birmingham.
26,937. PADS for FELT HAT FINISHING MACHINES, E. Batterbby, Manchester.
26,938. APPLIANCES for RULING PAPER, J. Campbell, Glasgow.
26,939. SEATS, H. W. and A. Guthrie, Liverpool.
26,940. DISTANCE MEASURING MACHINE, J. Thomas, Newcastle-on-Tyne
26,941. WINDOW FASTENINGS, A. Mair, Glasgow.
26,942. QUICK-TRAVERSE WINDING FRAMES, C. D. Taylor, Sale, Cheshire.
26,943. MULTIPLE-WAY VALVES, R. R. Revis and J. H. Gibson, London.
26,944. OPERATING RIM BRAKES, H. A. Lamplugh, Birmingham.
26,945. PENHOLDER, B. Schmitz, Germany.
26,946. LADIES' BELT, V. R. Humphrey, Pa., U.S.A.
26,947. AUTOMATIC ELECTRIC STREET INDICATORS for CARS, F. H. Wehrmann, Missouri, U.S.A.
26,948. FEEDER for CATTLE, W. B. Hayes, Tralee, Ireland.
26,949. WEAVING MACHINERY, S. Tattersall, W. Chadwick, and F. W. Bayliss, London.
26,950. MOTOR CYCLES, C. E. Simms, London.
26,951. INK, W. Rosenhain, London.
26,952. TOBACCO PIPES, E. W. Taylor, London.
26,953. MANUFACTURE of PRINTING SURFACES, S. Booth, London.
26,954. MECHANICAL DEVICE for LIFT, A. C. Moffatt, London.
26,955. FOUNTAIN PENS, H. L. Todd, London.
26,956. CYCLES, C. F. Grapes, London.
26,957. MACHINES for FORMING the NECKS of BOTTLES, J. Forster, London.
26,958 RESERVOIRS, F. E. Fletcher and International Shoe Findings, Limited. London.
26,959. TRANSMITTING POWER, H. V. Holden and E. T. Headech. London.
26,960. WOOD and IRON BUILDINGS, T. E. Lake, London.
26,961. SWITCHING MECHANISM, J. McCullough, London.
26,962. EMERGENCY HOOK for RAILWAY VEHICLES, H. R. O. Friederici.—(*F. Stepan, Austria.*)
26,963. SUSPENSION of MAGNETIC COMPASSES, G. C. Lilley, London.
26,964. BICYCLE CRANKS and AXLE, W. F. Crook, Lewes, Sussex.
26,965. CLUTCH for ELECTRIC ARC LAMPS, H. B. Swift, London.
26,966. SOUND-RECEIVING INSTRUMENTS, A. N. Petit, London.
26,967. ELECTRIC SWITCH, A. T. Wedelin, London.
26,968. FASTENING DEVICE for BRACELETS, E. Drews, London.
26,969. HOLDER for NIGHT LIGHTS, J. A. Macmeikan, London.
26,970. FITTINGS for WINDOW CURTAINS, J. A. Macmeikan, London.
26,971. DIMINISHING the DUST RAISED by MOTOR CARS, G. L. Cumberland, London.
26,972. PREVENTING the REFILLING of BOTTLES, A. Guattari and F. W. E. Gruggen, London.
26,973. ADMINISTERING ANÆSTHETICS, H. W. Franklin, London.
26,974 MANUFACTURE of ARTIFICIAL FUEL, W. B. Hartridge, London.
26,975. ANCHORS, D. S. and J. Holloway, London.
26,976. PRODUCING FUMES from ORES, W. W. Fyfe, London.
26,977. VALVES, G. W. Koehler, London.
26,978. MANUFACTURING EXPLOSIVE COMPOUNDS, M. S. Talbot, London.
26,979. GUIDE APPARATUS for DRIVEN TURBINES, A. G. Bloxam.—(*G. Sulzer, Switzerland.*)
26,980. REVOLVERS for NIGHT USE, W. Meischke-Smith, London.
26,981. CIGARETTE TUBE MOUTHPIECES, A. J. Boult.—(*H. L. Händel, Germany.*)
26,982. SUPPORTING the CRUST of PIES, A. R. Roe, Norfolk.
26,983. CYCLES, S. Downing, London.
26,984. MAKING THIN THREADS from SHORT FIBRES, C. Kellner, London.
26,985. GOLF BALLS, G. Sutton, London.
26,986. FRICTION CLUTCHES, A. Hérisson, London.
26,987. MOTOR CARS, R. R. F. Butler, London.
26,988. TRANSPORTING APPARATUS, W. P. Bullivant and B. Vallance, London.
26,989. FIXING HAND LEVERS in POSITION, H. J. Dawson, London.
26,990. VARIABLE THROW CRANK, E. T. G. C. Grinlinton, London.
29,291. A RELEASING BUCKLE STIRRUP BAR, J. Martin, London.
26,992. JACQUARD MACHINES, B. J. B. Mills.—(*Soc. Anon. des Mécaniques Verdol, France.*)
26,993. SPEED INDICATOR for MOTOR CARS, F. D. Wilson, London.
26,994. TOOTH BRUSH, M. Jakobovics, London.
26,995. SUSPENSION of VEHICLES, G. F. Brouhot, London.
26,996. CONSTRUCTION of AMMONIA STILLS, G. E. Davis, London.
26,997. DOUBLE-ACTING PUMPS, J. Grundel, London.
26,998. TRAVELLER for TIP BASKETS, W. C. Fairweather.—(*J. Downie, Uruguay.*)
26,999. FASTENING RING for CIGARS, O. Denker, London.
27,000. FOOT WARMERS, A. M. and A. Dilks, London.
27,001. WATER WHEELS, F. Kirchbach, Liverpool.
27,002. WRENCHES for PIPES and TUBES, H. Redhead, London.
27,003. LIFE BOATS, R. D. Mayo, London.
27,004. AIR TUBES for PNEUMATIC TIRES, J. Tarpin, London.
27,005. AID TO WEAK MEN, M. Liflandshif, London.

10th December, 1903.

27,006. MEASURING APPLIANCES, W. Tucker, Ashton-under-Lyne.
27,007. CONSTRUCTING FILTERING APPARATUS, C. J. Haines, Winchester.
27,008. SIGN PLATES for MOTOR CARS, C. H. Worsnop, Halifax.
27,009. ADJUSTABLE HEELS for BOOTS, J. T. Sutcliffe, Burnley.
27,010. REGULATING the SUPPLY of WATER to BOILERS, D. Horsburgh and H. S. Walker, Prestwich, near Manchester.
27,011. SLEEVE LINK, H. J. Page, London.
27,012. ANTI-JUMPING DEVICE for MOTORS, T. H. Tuite, London.
27,013. APPLIANCE for PUNCHING METAL PLATES, C. E. Beardmore, Bothwell, N.B.
27,014. TAKING SERIES of PHOTOGRAPHS, T. and E. O. Brown, Salisbury.
27,015. NAILING MACHINES, A. R. Timson, C. W. Bullock, and C. S. Barber. Kettering.
27,016. RUBBER HEELS for BOOTS, F. H. Barker, Manchester.
27,017. PREVENTING SIDE-SLIP in MOTOR CARS, F. S. Willoughby, Manchester.
27,018. PHYSICAL CULTURE APPARATUS, E. H. Miles, Cambridge.
27,019. MANUFACTURE of FANCY SOAPS, G. F. Powell, Bristol.
27,020. CONSTRUCTION of METAL BRACKETS, J. Tipper, Wolverhampton.
27,021. PHOTOGRAPHIC SLIDES, W. Holden and J. Schofield, Manchester.
27,022. MAKING STAIR-ROD EYES, J. J. James, Birmingham.
27,023. CONSTRUCTING FIREPLACES, A. H. Miller, Felling-on-Tyne.
27,024. SURGICAL OPERATING TABLE, M. Billingsley, Birmingham.
27,025. TIN OPENERS, B. A. Wright, Birmingham.
27,026. TOP OBSTACLE RACE GAME, W. F. Moore, Preston.
27,027. SOCK SUSPENDERS, G. W. Brough, Nottingham.
27,028. BARROW FOR CARRYING LADDERS, A. Barr, Glasgow.
27,029. INDICATORS for SHOWING DRAUGHT of VESSELS, J. Shaw and J. Grant, Wallsend.
27,030. WINDING MACHINES, W. R. Hicks, Belfast.
27,031. PROMOTING VENTILATION, J. H. Pinnock, P. C. Ruhsen, and O. F. Seeley, London.
27,032. DYNAMO-ELECTRIC MACHINES, H. Chitty, London.
27,033. RIGHT and LEFT BOOT RACK, T. Randall, Northampton.
27,034. COAL ECONOMISER, T. Ray, Sunderland.
27,035. COMBINED TROUSER PRESS, H. M. Maxey, Liverpool.
27,036. VEHICLE WHEELS, C. Blair, Liverpool.
27,037. STEAM ENGINES, H. B. Watson and T. C. Billetop, Liverpool.
27,038. SAND VALVE GEAR, H. Liddle, Newcastle-on-Tyne.
27,039. SCREENING CHEMICAL MANURES, E. Newell, Misterton, near Gainsborough.
27,040. TWISTING RAILWAY RAILS, G. Whale, Crewe.
27,041. FINGER GUARD for IRONING MACHINES, W. L. Bradford, Manchester.
27,042. ACETYLENE GAS GENERATOR, W. Mills, Manchester.
27,043. GEAR for MOWING MACHINES, C. Dahl and C. J. Lund, London.
27,044. SUBMARINE BOAT, G. G. M. Hardingham.—(*The Electric Boat Company, United States.*)
27,045. CLEAT for THEATRICAL SCENERY, M. Malone, London.
27,046. STREET CAR FENDER, R. Hirsch, Germany.
27,047. SAFETY BELT for MEN WORKING upon LADDERS, J. H. Heathman, London.
27,048. LETTER-COPYING MACHINES, M. J. Foyer, London.
27,049. BALLOONS, A. H. P. Blunt, London.
27,050. INTERNAL COMBUSTION ENGINE, T. W. Buckney, London.
27,051. FASTENINGS for LIDS of BOXES, G. Strong, London.
27,052. KEEPING NECKTIES in POSITION, A. H. Jay, London.
27,053. INDEXING, C. Wray, Croydon.
27,054. PUNCHING BAG APPARATUS, H. S. Mills, London.
27,055. FURNACE DRAUGHT APPARATUS, A. Ross and C. E. Vernon. London.
27,056. GOLF INSTRUCTION DEVICE, G. W. Beldam, Liverpool.
27,057. WICKER HAMPERS, P. M. Prager, London.
27,058. PRESERVATION of POTATOES, G. Holtz, London.
27,059. PHOTOGRAPHIC FILMS, E. F. Beckwith and T. A. Carter, London.
27,060. ARC LAMPS, A. Cotis, London.
27,061. HEARTH STANDS and FIRE-GUARDS, J. A. Macmeikan, London.
27,062. COMBINATION POCKET PENCIL-CASE, A. Heer, London.
27,063. BALL VALVES, W. R. Pryke and W. Palmer, London.
27,064. PAPER PUZZLES, B. W. Hird, London.
27,065. MATERIAL for REPAIRING PNEUMATIC TIRES, F. Woodgates and T. W. Jourdan, London.
27 066. INCANDESCENT GAS LAMPS, J. W. B. Wright an H. Darwin, London.
27,067. INCANDESCENT GAS LAMP, J. W. B. Wright and H. Darwin, London.
27,068. COIN-FAKED APPARATUS, J. Jofeh, London.
27,069. OPERATING POINTS on TRAMWAYS, C. C. Cardell, London.
27,070. DISCHARGING COLOURING MATTERS on FIBRE, H. E. Newton.—(*Farbenfabriken vormals F. Bayer and Co., Germany.*)
27,071. WORK BENCHES, R. N. Fairbanks.—(*The Fairbanks Company. United States.*)
27,072. ABDOMEN PAD for CRICKETERS, R. H. Fish and H. Peace, London.
27,073. DIRECTING MECHANICAL MOVEMENT from a DISTANCE, L. Torres, London.
27,074. AUTOMATICALLY SCOURING the RIMS of WHEELS, R. J. and H. A. Edwards, London.
27,075. INDICATING the RELATIVE SPEEDS of TWO SHAFTS, W. H. Newman, London.
27,076. TELESCOPES, T. R. Dallmeyer, London.
27,077. TOBACCO PIPES, J. W. Scott, London.
27,078. ANTI-SKIDDING TIRES, D. Couverchel and J. Billet, London.
27,079. CONSTRUCTING INDUCTION COILS, C. C. Fontaine, London.
27,080. TOBACCO PIPES, H. T. Sugden, London.
27,081. PROJECTILES, A. T. Dawson and J. L. S. Benthall, London.
27,082. WHITE METALLIC ALLOY, R. B. Wheatley, London.
27,083. TIRES and WHEELS of RIMS, J. H. Barry, London.
27,084. LOCKS, A. E. Wilson, London.
27,085. DEFECATOR, W. P. Thompson.—(*M. Reimanns, Holland.*)
27,086. GOVERNING MECHANISM for FLUID-ACTUATED MOTORS, W. P. Thompson.—(*H. Holzwarth, United States.*)
27,087. BEARINGS, W. P. Thompson.—(*H. Holzwarth, United States.*)
27,088. TURBINES, W. P. Thompson.—(*H. Holzwarth, United States.*)
27,089. BINDING AGENT for BELTINGS, P. C. D. Castle, Liverpool.
27,090. ELASTIC CONNECTIONS of CANNON, V. J. Poutet, London.
27,091. PNEUMATIC TIRES, J. S. Smith, London.
27,092. INDIA-RUBBER WHEEL TIRES, G. Radmore, London.
27,093. RECOIL BRAKES for GUNS, C. D. Abel.—(*Rheinische Metallwaaren und Maschinenfabrik, Germany.*)
27,094. APPARATUS for BENDING TUBES, W. Kennedy, London.
27,095. ENGINES, T. W. Barber, London.
27,096. AUTOMATIC FLUSHING of LIQUIDS, F. P. Candy, Redhill.
27,097. OPERATING TRAMWAY POINTS, A. E. McCracken, London.
27,098. INTERNAL COMBUSTION ENGINES, W. H. Barrett, London.
27,099. STOOL, SEAT, and WALKING STICK, F. W. Duckett, London.
27,100. MANHOLES for CONDUITS, H. C. Baker, jun., London.
27,101. TRANSMITTING PISTON MOTION, F. Brückert, London.
27,102. DISTORTING MIRRORS, T. J. and J. W. Ide, London.

11th December, 1903.

27,103. MANUFACTURE of PADLOCKS, F. W. Pinson, Willenhall, Staffs.
27,104. CINDER SIEVES, M. J. Adams, Scotswood-on-Tyne.
27,105. FIREPLACES, M. J. Adams, Scotswood-on-Tyne.
27,106. BUFFERS, G. Turton, Sheffield.
27,107. FURNACE DOORS, G. H. Timmis, Birmingham.
27,108. PRINTING MACHINES, R. B., H., S., and F. S. Furnival, Manchester.
27,109. POWDER for POLISHING PLATE, M. E. Burrows, Manchester.
27,110. SMALLWARE LOOMS, T. Burgess, L. H. Renshaw, and J. J. Burgess, Manchester.
27,111. MARINE BOILERS, C. Jacobi, Manchester.
27,112. MACHINES for COMBING FIBROUS MATERIAL, W. H. Greenwood and F. Farrar, Bradford.
27,113. ENDLESS BAND for DRIVING MOTOR CYCLES, T. Harrison, Stockton-on-Tees.
27,114. LOCKS for TRAVELLING TRUNKS, T. O. Cole, Birmingham.
27,115. MACHINERY for SPINNING YARNS, J. and H. Wright, Keighley.
27,116. ATTACHMENT for BILLIARD TABLES, F. A. Calvert, Manchester.
27,117. SHUTTLE-BOX MOTIONS of LOOMS, E. Hollingworth and W. Paton, Huddersfield.
27,118. COLLECTOR PULLEYS for ELECTRIC RAILWAYS, R. Bostock, Halifax.
27,119. PICKERS of LOOMS, J. J. Whalley, Halifax.
27,120. HEATING STOVES, T. and G. Perry, Wolverhampton.
27,121. SELF-SEALING RETORT LIDS, J. Barker, Dundee.
27,122. CARBURETTERS, J. van Hooydonk, London.
27,123. TAKING SERIES of PHOTOGRAPHS, T. and E. O. Brown, Salisbury.
27,124. CONSTRUCTION of BATHS, W. J. Newton, Accrington.
27,125. TILTING TABLE for HOOKING CLOTH, J. B. Barton, Manchester.
27,126. BOTTOMLESS PIPE, H. Rogers, Sunderland.
27,127. FIXING BLINDS to ROLLERS, J. C. Ferguson, London.
27,128. VENTILATING BUILDINGS and VESSELS, J. Taylor, Manchester.
27,129. CASTORS, C. Barter, London.
27,130. BELTING JOINT, F. Mitchell and F. Gunn, Manchester.

27,131. ELECTRIC TROLLEY POLES, J. W. Wilkinson, Manchester.
27,132. ZINC EXTRACTION, G. C. Marks.—(*G. D. Delprat, New South Wales*)
27,133. PROTECTIVE DEVICE for X-RAY TUBES, E. H. Harnack, London.
27,134. TRANSPORTING PARCELS, The British Cash and Parcel Conveyors, Limited, and E. C. Phillips, London.
27,135. CONVEYING PARCELS, The British Cash and Parcel Conveyors, Limited, and E. C. Phillips, London.
27,136. TRANSPORTING PARCELS, The British Cash and Parcel Conveyors, Limited, and E. C. Phillips, London.
27,137. SOLDERING ALLOY, A. Pflueger and O. Kuhn, London.
27,138. COLLATING SECTIONS of BOOKS, A. Hess, London.
27,139. DRESSING and TREASURE TABLE, F. C. M. Anthrobus, Salisbury.
27,140. AIR COMPRESSORS, E. Stephenson, London.
27,141. BOOT and SHOE PROTECTORS, T. Rappitt, London.
27,142. BURGLAR ALARMS for STRONG ROOMS, D. Burns, London.
27,143. EYEGLASSES, H. Davis, London.
27,144 AUTOMATICALLY CONTROLLING the FLOW of GAS, H. Davis, London.
27,145. RAZOR STROP, H. R. Spratt, London
27,146. CONTROLLING SUSPENDED SHIPS' BERTHS, W. Whitehouse, London.
27,147. LOCKING BOLTS, C. E. Long, London.
27,148. FASTENINGS for DOORS, C. E. Long and P. J. Waldron, London.
27,149. HYDRAULIC PISTON BRAKE MECHANISM, M. Mondragon, London.
27,150. STRING and TWINE CUTTER, E. J. W. Peirce, London.
27,151. GLASS IRONER, G. A. Bennett, Colchester.
27,152. AUTOMATIC HOT-WATER FEED DEVICE, E. Oechelhaeuser, London.
27,153. CONTROLLING APPARATUS for ELECTRIC SIGNALLING, J. T. Mitscherling, London.
27,154. PORTFOLIOS, H. P. Meehan, London.
27,155. PROTECTORS for BOOTS, H. J. S. Cassal, London.
27,156. TYPEWRITING MACHINES, A. J. Boult.—(*L. C. Smith and Bros. Typewriting Company United States.*)
27,157. EDUCATIONAL APPLIANCES, J. G. Bree, London.
27,158. MECHANICAL ADVERTISEMENTS, J. G. Bree, London.
27,159. NEEDLE-FEEDING APPARATUS for GRAMOPHONES, A. and M. Oppenheimer, London.
27,160. ADJUSTABLE HANDLE-BARS for CYCLES, S. Zeyland, London.
27,161. SCREW STOPPERS for BOTTLES, F. A. Ellis, London.
27,162. EXPANSION BOLT, W. T. Whiteman.—(*N. H Steward, United States.*)
27,163. COUPLINGS, S. J. Deverill, London.
27,164. BRAKES for BICYCLES, E. Edwards.—(*W. W. West and H. Gilbert, Transvaal.*)
27,165. BOLTS for DOORS, E. Tietzsch, London.
27,166. SOLES and HEELS of BOOTS, B. Wittenberg, London.
27,167. COMPOSITION for STEAM JOINTS, A. A. van Daelen, London.
27,168. AXIALLY TRANSMITTING MOTION, A. Monski, London.
27,169. CUFF LINKS, J. H. Thomas, London.
27,170. SEASONING TIMBER, R. H. Seaton, London.
27,171. INSULATING ELECTRICAL COILS, H. Chitty, London.
27,172. HARDENING of METALS, S. Cowper-Coles and Co., Limited, and S. Cowper-Coles, London.
27,173. CONNECTOR for ELECTRIC CIRCUITS, W. H. Kelsey, London.
27,174. LOOSE LEAF LEDGERS, W. N. Winfield and J. Barker, London.
27,175. GAS BLOW-PIPES, E. Fouché, London.
27,176. MOTOR BICYCLES, W. A. Suddard, London.
27,177. TIRES for WHEELED VEHICLES, F. H. Sterling, London.
27,178. TIRES for WHEELED VEHICLES, F. H. Sterling, London.
27,179. SACK-SUPPORTING DEVICES, W. H. Cruddas, London.
27,180. APPARATUS for FEEDING MAIZE EARS, E. Vladescu, London.
27,181. COOLING ENGINE CYLINDERS, W. S. Simpson, London.
27,182. FIRE-PREVENTING VESSEL, L. Wienand, London.
27,183. SKIRT or WAIST HOOK ATTACHMENT, E. Binder, London.
27,184. PACKINGS, W. Walker, Liverpool.
27,185. DRAIN GULLETS, T. Searson and S. H. Wright, Liverpool.
27,186. PRELIMINARY TREATMENT of LOCUST KERNELS, R. Gray, G. Osborn, H. B. Stocks, and H. G. White, Liverpool.
27,187. WHEELS for PNEUMATIC TIRES, J. Y. Johnson.—(*The Société Anonyme des Forges de Douai, France.*)
27,188. PRINTING MACHINES, Coulthard and Co., Limited, and T. Coulthard, London.
27,189. CONTROLLING ELECTRIC VOLTAGE, I. Deutsch, London.
27,190. PUMPS, B. Gehlig, London.
27,191. PRODUCING DESIGNS upon METALLIC SURFACES, S. Cowper-Coles and Co., Limited, and S. Cowper-Coles, London.
27,192. FASTENERS for BOOTS and SHOES, J. J. Blok, London.
27,193. BIT-STOCKS, A. Novitzki, London.
27,194. MANUFACTURE of LEAD PEROXIDE, A. G. Bloxam.—(*Société Anonyme d'Etudes Electro-Chimiques, Switzerland.*)
27,195. DISTANCE-INDICATING INSTRUMENT, F. Wray, London.
27,196. SWITCHES, C. E. Hunter, London.
27,197. SECURING BOTTLE STOPPERS, F. W. Schroeder, London.
27,198. RECOVERY of IRON from PYRITES, H. Solbisky, London.
27,199. ELECTRICAL ARC LAMPS, F. M. Lewis, London.
27,200. STARTING INTERNAL COMBUSTION ENGINES, P. St. G. Kirke, London.
27,201. WHEELS, L. Hitchcock, London.
27,202. SPREADING MACHINES, The Velvril Company, Limited, and J. S. R. Howkins, London.
27,203. SOAP HOLDER, F. Fergusson, London.
27,204. RAILWAY SWITCH with CHAIN RAIL, E. P. Dupuis, London.
27,205. CHANGE GEARS, P. Bardsley, London.
27,206. WHEELS for ROAD VEHICLES, W. H. A. Theed, London.
27,207. BEDSTEADS, H. Schiffers, London.
27,208. CLOCKWORK MECHANISM, H. Reddöhl, London.
27,209. CONTROLLING SPEED of MOTORS, J. Wyss, London.
27,210. SPRAY VAPORISERS for ENGINES, J. Wyss, London.
27,211. VENTILATORS, W. G. Gagné, London.
27,212. IMPARTING STABILITY to VEHICLES, L. Brennan, London.
27,213. WINDING MOVING COILS, R. O. Heinrich, London.
27,214. RECORDING or TRAP NESTS, G. J. G. Jensen, London.
27,215. WOVEN BUTTONHOLES, E. M. S. Jones, London.

12th December, 1903.

27,216. LAMP SHADE FRAMES, C. M. Escaré, London.
27,217. SEPARATING LIGHT DUST, J. B. Holgate and C. Clough, Blackburn.
27,218. RELIABLE SUN BLIND WINDER, R. Forrest, Liverpool.
27,219. TREATMENT of SEWAGE SLUDGE, S. E. Boivie, Manchester.
27,220. AUTOMATIC STOP APPARATUS of STEAM ENGINES, J. Naylor and G. Hodgson, Limited, Halifax.
27,221. SHEDDING and PACKING MOTIONS of LOOMS for WEAVING, G. H. and M. E. Hodgson and G. Hodgson, Limited, Halifax.
27,222. REEDS for LOOMS, T. E. Dean, Manchester.
27,223. NAIL, A. J. Lehmann, Liverpool.
27,224. ACETYLENE GENERATORS, Lockerbie and Wilkinson, Limited, J. C. Braud, Birmingham.
27,225. FEEDING MECHANISM for ACETYLENE GAS GENERATING APPARATUS, J. H. Luby and W. Harris, Bristol.
27,226. TRANSMITTERS for GRAPHOPHONES, O'H. J. Tobin, Bristol.
27,227. CONSTRUCTION of ROOFS of BUILDINGS, J. Copage, L. P. Appleton and E. Enstone, Birmingham.
27,228. CONSTRUCTION of BUILDINGS, J. Copage, L. P. Appleton, and E. Enstone, Birmingham.
27,229. CARPENTERS' BENCHES, W. J. George, Birmingham.
27,230. GRIPPING DEVICE for TURNING TOOLS, A. and H. Roberts, Manchester.
27,231. OIL LAMPS for HEATING PURPOSES, E. Sherring, Manchester.
27,232. OIL LAMPS for HEATING PURPOSES, E. Sherring, Manchester.
27,233. COCKS and TAPS, J. B. Wideman.—(*J. A. Bergström, Sweden.*)
27,234. TARGETS, H. W. Bull, London.
27,235. BOOT TREES, W. Watson, Glasgow.
27,236. CYCLES, J. Howie, Glasgow.
27,237. TARGETS for RIFLE RANGES, C. E. Luard, Ightham, near Sevenoaks.
27,238. FOOTBALL BOOTS, F. Sugg, Liverpool.
27,239. QUARTER CRAN HERRING BASKETS, A. McLean, Leith, N.B.
27,240. REVOLVING SOLE or HEEL PAD, G. Brown, Glasgow.
27,241. FIRE-PROOF FLOORS and ROOFS, J. R. Little, Glasgow.
27,242. VALVES for VACUUM PANS, J. Harvey.—(*R Hamilton, Penang.*)
27,243. TIRES for MOTOR VEHICLES, W. H. and E. P. Castlehouse, and C. D. Burton, Scarborough.
27,244. BALL-RIMMED WHEELS for RUNNING on METAL RAILS, F. T. Penty, Lendal, York.
27,245. KNIFE or FORK CLEANERS, W. T. Robertshaw, Manchester.
27,246. APPARATUS for RAISING the NAP on SCOTCH BONNETS, J. Picken, London.
27,247. RUBBER HEELS for BOOTS, F. H. Barker, Manchester.
27,248. LOCKS for MINERS' SAFETY LAMPS, L. N. Williams, Bristol.
27,249. TREATING OXYGEN, P. Garuti and C. R. Pompili, London.
27,250. CARDED WOOL YARN-SPINNING MACHINES, W. Achenbach and O. Dick, London.
27,251. FLOWER-POTS, E. O. Adcock, London.
27,252. LEATHER DRIVING BELTS, A. J. Boult.—(*E. Csaika, Germany.*)
27,253. SCARF PINS, W. F. Beckett, Birmingham.
27,254. SPRING MATTRESSES, G. Crerar, Glasgow.
27,255. BABIES' FEEDING BOTTLES, A. Hamers, Hanover, Germany.
27,256. SUPPLYING FUEL to BOILER FURNACES, H. Lemke, Hanover, Germany.
27,257. A SUCTION HOLDFAST, A. C. Ellis, London.
27,258. CHANGING BOXES for CAMERAS, A. L. Adams, London.
27,259. INCANDESCENT GAS BURNERS, J. R. Park, London.
27,260. TIRES for WHEELS of CYCLES, F. Tolkien, London.
27,261. SURGICAL APPLIANCE, M. L. Bentley, London.
27,262. CUFFS, R. Sowerbutts, Chorley, Lancs.
27,263. BALE TIE, P. Heyden, London.
27,264. SIGHTS for SMALL-ARMS, L. G. P. Thring, London.
27,265. CABLES, O. J. Lodge and A. R. Hardy, London.
27,266. CLEANING and POLISHING CUTLERY, F. C. Howard, London.
27,267. SUSPENDING ELECTROLIERS, L. Milne, London.
27,268. GAME, W. M. Treloar, London.
27,269. BOTTLES, T. E. O'Brien, Liverpool.
27,270. BOTTLE STOPPERS, A. Schroedter and E. Wernscheid, Liverpool.
27,271. JOINTING TOGETHER PIPES, J. Russell, London.
27,272. IMPROVING the EFFICIENCY of TURBINES, A. R. Dodge, London.
27,273. IMPROVING the EFFICIENCY of TURBINES, A. R. Dodge, London.
27,274. GOVERNING VALVES, The Warwick Machinery Company, Limited.—(*The General Electric Company, United States.*)
27,275. NOZZLES for TURBINES, The Warwick Machinery Company, Limited.—(*The General Electric Company, United States.*)
27,276. RELIEF MECHANISM for TURBINES, The Warwick Machinery Company, Limited.—(*The General Electric Company, United States.*)
27,277. SOCKETS for COUPLING PIPES, F. G. Jones, London.
27,278. CHAIN-LINK SHACKLES, H. H. Lake.—(*Duisburger Maschinenbau Aktien Gesellschaft vorm. Bechem and Keetman, Germany.*)
27,279. GAS BURNERS, L. J. Reinhardt, London.
27,280. DUST CHAMBERS, F. Cazan and L. J. W. Jones, London.
27,281. SPRING MATTRESSES, A. Ostheimer, London.
27,282. HAND CAMERAS, H. J. Haddan.—(*R. Guenault, France.*)
27,283. COUNTERS for ELECTRIC CURRENT METERS, F. Biermann, London.
27,284. DRIVING TURBINES, K. Schultze, London.
27,285. MANUFACTURE of OZONE, E. G. P. Bousfield, London.
27,286. CENTRIFUGAL FANS, G. Meidinger, London.
27,287. FILTERING APPARATUS, J. Wetter.—(*E. Boettinghaus, Germany.*)
27,288. HERMETICALLY ENCLOSING SUBSTANCES, H. S. Welcome and A. T. Hill, London.

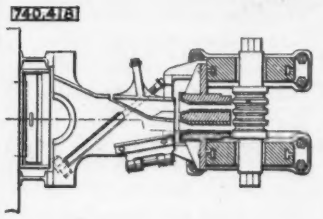
SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

740,418. FEEDING MECHANISM FOR ROLLING MILLS, *J. R. George, Worcester, Mass.—Filed July 3rd*, 1902.

Claim.—(1) The combination with a pair of rolls having two sets of circumferential grooves forming passes for a billet, and a billet-supporting table in front of said rolls, of a vertically movable plate normally held in the plane of the supporting table, raised flanges on said movable plate between which a billet is conducted to one of the passes in said rolls, and a vertically-movable guide plate by which the advancing end of a billet is deflected upon said movable

740,418

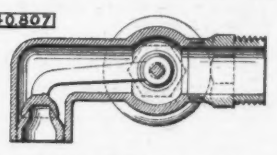


plate, substantially as described. (2) The combination with a pair of rolls having two separate passes and a billet-supporting table in front of said rolls, of a plate capable of a vertical movement from a position flush with the table to one above the table, a raised guiding flange on said plate by which a billet is directed into one of said roll passes, a guide for directing a billet across said plate, said guide being capable of being depressed below the surface of the table, and a fixed guide on said table whereby a billet is directed into the other of said passes in the rolls, substantially as described.

740,807. VALVE, *J. H. Clune, Springfield, Mass.—Filed September 23rd*, 1901.

Claim.—In a basin cock having the usual downhanging nozzle, a valve movable vertically in the latter, a valve seat secured to or near the end of the nozzle below the valve, a curved arm on which the

740,807

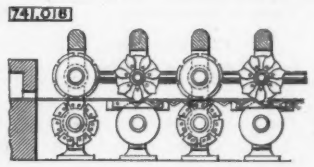


valve is supported extending back into the body of the cock, a valve stem extending through the side of the cock at right-angles to said arm, the latter and said stem being secured together to move as one piece.

741,016. MACHINE FOR MAKING EXPANDED METAL, *J. F. Craven, Pittsburg, Pa.—Filed February 26th*, 1903.

Claim.—(1) In a machine for forming expanded metal, the combination of a series of discs or rolls, means for rotating the same, one or more expanding devices carried by each of said rolls, and means for moving said expanding device or devices radially on

741,016

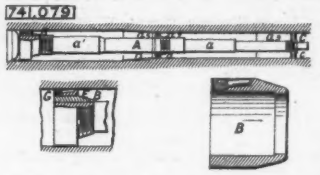


the disc or roll. (2) In a machine for forming expanding metal, the combination of a series of sets of slitting and expanding devices, each set comprising a pair of co-operating slitting rolls and an expanding roll or disc, one or more expanding devices carried by said expanding roll or disc, and means for moving said expanding device or devices radially on the roll or disc.

741,079. AUXILIARY BARREL FOR BREECH-LOADING GUNS, *V. C. Tasker, Washington, D.C.—Filed February 21st*, 1903.

Claim.—(1) The adapter for a subcalibre gun, con-

741,079

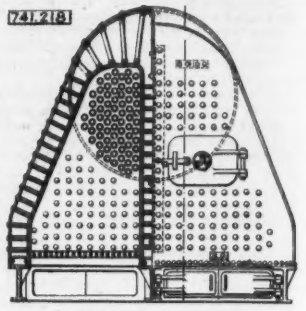


sisting of a main portion having an oblique screw-seat provided with an opening at the edge of such main portion, a screw in said seat, the inner end of the screw being at such opening, and a sleeve outside of the main portion having a flexible part where the end of the screw comes to the opening. (2) The combination of the ring E, having the oblique screw seat e^1, and the opening e^6, the screw G fitting in such screw seat and having its end g^2 at the opening e^6, and the sleeve F having the tongue f located at the opening e^6.

741,218. FIRE-BOX, *W. D. Boyce, St. Louis, Mo.—Filed March 3rd*, 1902.

Claim.—In a fire-box, an inclosing shell, an end casing-plate, interior walls spaced apart and dividing

741,218

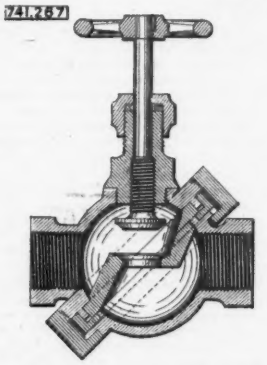


said fire-box, said casing and plate extending across the space between said walls, and a tie-rod secured to said end plate and extending in the space between said walls, substantially as described.

741,267. VALVE, *L. W. Neubling, Indianapolis, Ind.—Filed January 5th*, 1903.

Claim.—A valve consisting of an inlet section and an outlet section mating upon a plane intersecting the axes of the inlet and outlet, a valve carried by one of said sections substantially at right angles to the

741,267

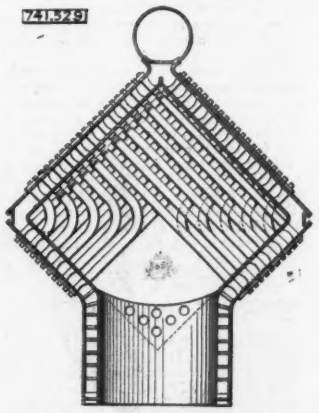


axis of the opening therein, a valve-seat partition lying between the two sections in the mating plane and having a valve seat displaced from the plane of the partition and substantially normal to the axis of the valve, means for detachably clamping the valve-seat partition upon the valve-stem section, and independent means for clamping the two sections together with the valve partition between.

741,529. STEAM BOILER, *J. M. McClellon, Everett, Mass.—Filed May 6th*, 1902.

Claim.—(1) A locomotive boiler having an inner shell polygonal in cross-section and constituting a flue, one end of said shell being shaped to form a fire-box, an outer shell concentric with the inner shell and forming with the latter a water chamber between said shells, inclined water tubes extending across the

741,529



inner shell and communicating with the water chamber, and means to prevent the sides of the outer shell from spreading. (2) In a locomotive boiler, two concentric shells forming between them a water chamber, each shell being substantially square in cross-section and having its diagonals situated vertically and horizontally respectively, a steam dome extending longitudinally of the boiler and connected thereto throughout its length, each side of the dome being secured to the edge of the adjacent side wall of the outer shell, and a stay member spanning the throat of the dome.

END OF VOL. XCVI

The Engineer.

Registered as a Newspaper

OFFICE FOR ADVERTISEMENTS AND PUBLICATION, 33, NORFOLK STREET, STRAND, W.C.

VOL. XCVI.—No. 2504] LONDON: FRIDAY EVENING, DECEMBER 25, 1903. [PRICE {WITH SUPPLEMENT} SIXPENCE.

PATENTS, DESIGNS, AND TRADE MARKS ACTS, 1883 to 1888.

Notice is Hereby Given that JOHN GARVIE KINMOND and DAVID PEEBLES KIDD, both of Dundee, in the County of Forfar, Scotland, SEEK LEAVE to AMEND the Specification of Letters Patent No. 930 of 1897, granted to them for "Improvements in and relating to the Printing or Stamping of Colours on Sacks, Bags, Posters, and the like."

Particulars of the proposed amendment were set forth in the Illustrated Official Journal (Patents) issued on the 16th December, 1903.

Any person or persons may give Notice of Opposition to the Amendment (on Form G) at the Patent-office, 25, Southampton-buildings, London, W.C., within one calendar month from the date of the said Journal.

C. N. DALTON,
Comptroller-General.

2045

The Victoria University of MANCHESTER.
THE OWENS COLLEGE.
WHITWORTH ENGINEERING LABORATORY.

A course of TEN DEMONSTRATIONS on the STRENGTH of MATERIALS, and the USE of the TESTING MACHINE, and a course of TEN TRIALS on the STEAM ENGINE, CENTRIFUGAL PUMPS, TURBINE and OIL ENGINES, with explanatory Lectures, will commence on FRIDAY, January 8th, at 6 30 p.m.

Fee for either course £1 1s. 2039

Aberdeen Harbour.—Dockisation OF RIVER DEE.
CONTRACT No. 1.

The Aberdeen Harbour Commissioners are prepared to receive TENDERS for the CONSTRUCTION of a TIMBER WHARF, about 750ft. long, and RELATIVE WORKS, on the North side of the River Dee, within the Port of Aberdeen.

The contract drawings may be seen at the offices of the undersigned between the hours of 10 a.m. and 4 p.m., on and after Wednesday, 16th December, and copies of the specification, schedule of quantities, and general plan and sections obtained on payment of Two Guineas, which will be returned in the course to bona fide offerers returning all the issued documents.

Tenders, endorsed "Tender for North Wharf, River Dee," are to be lodged with the undersigned not later than 12 o'clock noon, on Wednesday, 6th January, 1904.

R. GORDON NICOL,
Engineer.

Harbour Engineer's Office,
Aberdeen, 11th December, 1903. 1916

Bombay, Baroda, and Central INDIA RAILWAY COMPANY.

The Directors are prepared to receive up to noon on Tuesday, the 5th January next, TENDERS for the SUPPLY of the following STORES, viz.:—

1. Dog Spikes.
2. Intermediate Posts for Fencing.
3. Metals.
4. Rails.
5. Spring Steel.

Tenders must be made on forms, copies of which, with specifications, can be obtained at these offices on payment of £1a. each (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

T. W. WOOD,
Secretary.

Offices: Gloucester House,
Bishopsgate-street Without, London, E.C.,
21st December, 1903. 2019

Urban District Council of KETTERING.
ELECTRICITY METERS.

The Council invite TENDERS for the SUPPLY and DELIVERY of ELECTRICITY METERS.

Copies of the specification, with forms of Tender and general conditions, can be obtained from the undersigned on payment of £2 2s., which amount will be returned on receipt of a bona fide Tender.

The specification can be seen at (but not obtained from) the offices of the Consulting Engineers, Messrs. Kennedy and Jenkin, 17, Victoria-street, Westminster, London, S.W.

Tenders on the prescribed form, in sealed envelopes, and endorsed on the outside "Electricity Meters," must be delivered at my office on or before the 9th day of January, 1904.

The Council do not bind themselves to accept the lowest or any Tender.

By order,
JOHN BOND,
Clerk to the Council.

Council Offices,
Kettering,
15th December, 1903. 1987

Bengal Nagpur Railway Com- PANY, LTD.

ASSISTANT ELECTRICAL ENGINEER WANTED, who has had a thorough mechanical and electrical training.

Term of agreement three years, with option of extension thereafter, until the engagement be terminated by six months' notice on either side.

Salary Rs. 350 a month, with an annual increment of Rs. 50 a month from the beginning of the first calendar half year following the completion of each year's service, up to a maximum of Rs. 500 a month.

First-class passage to India will be provided.

Application to be made, with copies of testimonials, to the BENGAL-NAGPUR RAILWAY COMPANY, Ltd., 132, Gresham House, Old Broad-street, E.C., by 15th January, 1904. 2027

City of Birmingham.—Asylums DEPARTMENT.
NEW HOLLYMOOR ASYLUM.

The Asylums Committee require the SERVICES of a RESIDENT WORKING ENGINEER in connection with the above Institution.

He must be thoroughly competent to take charge of and deal with Lancashire boilers, Parsons' turbos, separate condenser, high-speed engines, continuous-current electric plant, laundry machinery, and hot and cold-water appliances, including the execution of all general repairs.

Applicants must have served an apprenticeship in some leading engineering works, and have satisfactorily filled a similar situation.

Wages, 50s. per week, with house, coal, and gas.

Also an ELECTRICAL ASSISTANT (to work under the Resident Working Engineer).

He must be thoroughly competent to take charge of shift, and to keep in order the whole electric lighting and motor installation, including the telephones, fire alarm, and other electrical installations, and also to carry out any minor alterations or extensions.

Applicants must be able to produce first-class certificates as to their having satisfactorily occupied a similar position.

Wages, 35s. per week, with housing, coal, and light.

Personal canvassing of members of the Council is prohibited.

Applications, stating age of applicants, whether married or single, with full particulars of qualifications and experience, and accompanied by copies of not more than three recent testimonials, must be sent to the undersigned, marked "Engineering," not later than Monday, January 4th, 1904.

WILLIAM HUTTON,
Clerk to the Visitors.

Council House, Birmingham,
December 17th, 1903. 2013

Staffordshire and Worcestershire CANAL COMPANY.

The Canal Company REQUIRE a GENERAL MANAGER in the place of the late Mr. Wm. Jones.

The Canal is 50 miles long, and connects with the Trent and Mersey Canal, the river Severn and the Cannock Chase coalfield.

Salary £350 to £500, according to experience.

Applications, stating age and qualifications and with testimonials, to be sent to the undersigned by the 30th of December, 1903.

JOHN NEVE,
Clerk to the Company.

Canal Offices, Wolverhampton. 2035

City of Birmingham. — The Public Works Committee invite APPLICATIONS for the APPOINTMENT of a TEMPORARY ENGINEERING ASSISTANT in the City Surveyor's Department, at a salary of £4 per week.

The appointment will last for a period of at least two years, subject to satisfactory service, after which it would be open to a month's notice on either side.

Candidates, whose ages should be between 27 and 35, must be expert levellers and surveyors, neat draughtsmen, and have had practical experience in designing and preparing working drawings, and details of river and heavy sewerage works on a large scale, and will be required to be well up in the preparation of specifications, quantities, and estimates.

Preference will be given to candidates who have passed the examination of the Institution of Civil Engineers or of the Association of Municipal and County Engineers.

The person appointed will be required to devote the whole of his time to the service of the Corporation, and subscribe to the Superannuation Fund.

Applications, in candidates' own handwriting, stating age, experience, and present employment, together with other particulars and copies of not more than three recent testimonials, and endorsed "Engineering Assistant," to be sent to the undersigned not later than Tuesday, January 12th, 1904.

Canvassing either directly or indirectly will be deemed to be a disqualification.

JOHN PRICE,
City Engineer and Surveyor.

The Council House, Birmingham,
December 21st, 1903. 2050

The Municipal Corporation of PORT ELIZABETH.
APPOINTMENT OF CHIEF SEWERAGE ASSISTANT.

The undersigned are authorised by cable to receive from gentlemen not over 40 years of age APPLICATIONS in detail for the above APPOINTMENT.

The candidates must be experienced in the preparation and execution of sewerage schemes and qualified to discharge such general duties in connection therewith as are usual in similar appointments under a British corporation.

The officer appointed will be required to devote the whole of his time to the duties of the office, and to enter into an agreement to remain in the service of the Corporation for a period of not less than two years, dating from arrival at Port Elizabeth.

The salary to be paid for the first year is £300 per annum and for the second year £350 per annum if approved by the Town Engineer.

The Corporation will supply the officer appointed with a second-class passage out.

Canvassing, personally or otherwise, whether in London, the provinces, or South Africa, will disqualify any candidate.

There is no special form of application. Each candidate is required to state (in addition to his professional status) his age last birthday, to set out the appointments he has held (and these in chronological order), and to forward copies (not originals) of not more than six testimonials of recent date.

The above applications must be deposited at the offices of the undersigned not later than Four o'clock p.m. on Wednesday, 20th instant.

DAVIS and SOPER,
Agents of the Municipal Corporation of Port Elizabeth.

54, St. Mary-axe, London, E.C.,
18th December, 1903. 2047

Wanted, Business Expert to ADVISE on the Staffing and Management of large Manufacturing Business. Iron and wood manufactures.—Apply, stating qualifications, to 2045, Engineer Office, 33, Norfolk-street, Strand, W.C. 2045

Wanted, by a Large Electrical Engineering Firm in the Eastern Counties, an INSPECTOR of MACHINE SHOP WORK; only men with similar experience need apply.—Address, fully stating age, salary expected, &c., 2041, Engineer Office, 33, Norfolk-street, Strand, W.C. 2041

Engineer. — Large Engineering Firm REQUIRES a MAN well up in design of Hydraulic Work, Machines, Pumps, Press Work, &c. &c. Must be capable of taking charge of the department. State training fully, with salary expected.—Address, 2055, Engineer Office, 33, Norfolk-street, Strand, W.C. 2055

For Burma.—Wanted at Once, MECHANICAL ENGINEER, age 25-30, experienced in high-class engine work, to Take Charge of Service of high-class Steam Cars. Training given for six weeks in shops before going out.—Apply, giving full particulars of experience, whether married or single, also references, with wages required, to CLARKSON, LIMITED, Steam Car Works, Chelmsford. 2014

Sugar Machinery Expert.—A large firm of British Sugar Machinery Manufacturers REQUIRE the SERVICES of an EXPERT ENGINEER, with experience of Design and Sugar Factory Management. Ability to control workshops is essential, as well as knowledge of modern processes and equipment. Candidates are requested to state their experience fully, giving copies of recent testimonials and naming salary expected. Applications from abroad should be mailed as early as possible.—Address, 1975, Engineer Office, 33, Norfolk-street, Strand, W.C. 1975

Wanted, a First-class Draughts- MAN for the Office of a London Firm manufacturing Constructional Steel Work of all descriptions. Only first-class men need apply. Good salary paid to competent man.—Address, stating particulars of previous employment and salary required, to 1765, Engineer Office, 33, Norfolk-street, Strand, W.C. 1765

Wanted, by a Firm in the North of England, a capable DRAUGHTSMAN, who has had special experience in design of high-class direct-driven double-acting boiler feed pumps. When applying kindly state experience, age, and salary required.—Address, 2051, Engineer Office, 33, Norfolk-street, Strand, W.C. 2051

Wanted, Car Draughtsman, first-class man as ASSISTANT to CHIEF, good at checking and good organiser; one with some tramcar experience preferred.—Address, stating age, experience, present position, and salary expected, 2042, Engineer Office, 33, Norfolk-street, Strand, W.C. 2042

Wanted, First-class Mechanical DRAUGHTSMAN. Must be accustomed to Elevators and Conveying Work.—Apply, stating experience, age, and salary required, to HOBERT DEMPSTER and SONS, Limited, Elland. 2039

Wanted, for the North of Ireland, a DRAUGHTSMAN having experience with the burning of oil fuel in marine boilers.—Address, stating age, qualifications, and wages expected, 2044, Engineer Office, 33, Norfolk-street, Strand, W.C. 2044

Assistant Draughtsman Wanted, age 24 to 33; experienced in designing throughout portable, undertype, traction, and stationary engines, simple and compound, loco. and Lancashire boilers, &c.—Address, stating fully age, experience, and salary required, Messrs. RANSOMES, SIMS and JEFFERIES, Limited, Ipswich. 204

Draughtsman.—Wanted, for the North of Ireland, an active, capable MAN, with good knowledge of General Engineering, Steam, &c. State age, where previously employed, and salary expected.—Address, 2056, Engineer Office, 33, Norfolk-street, Strand, W.C. 2056

Draughtsman Wanted; One with experience on Boring Mill Drills, &c. State qualifications, age, salary.—Address, 2049, Engineer Office, 33, Norfolk-street, Strand, W.C. 2049

Engineer's Drawing-office PREMIUM APPRENTICE WANTED.—DOUGLAS, Baltic Wharf, Putney. 2040

Head Draughtsman Required for Constructional Steelworks in London; must be thoroughly experienced in planning steelwork for buildings, &c. State full particulars of experience, age, salary required, and when at liberty.—Address, 1941, Engineer Office, 33, Norfolk-street, Strand, W.C. 1941

Bridge Yard Foreman.—Wanted, as ASSISTANT FOREMAN, a thoroughly competent man, accustomed to high-class bridge and structural work.—Apply, stating age, experience, and wages required, to the TRESIDE BRIDGE and ENGINEERING WORKS, LTD., Cargo Fleet, Middlesbrough. 1912

Wanted, a Leading Hand to Take Charge of the Dry Sand Moulding in a large Iron Foundry in the Midlands. He must have had experience in coring and closing up cylinders, condensers and general engineering work, and must have been accustomed to piece work.—Write, giving age, experience, and references, also wages expected, to 1966, Engineer Office, 33, Norfolk-street, Strand, W.C. 1966

Addresses of German Engineers and TECHNICIANS OPEN to ENGAGEMENT in England or abroad may be OBTAINED FREE OF CHARGE from Messrs. SCHULZ and CO., Publishers of the "ALLGEMEINE TECHNISCHE VERKEHRSBLATT," Berlin, S.W., 19. 894

Advertiser Desires Post Imme- DIATELY, 8 year' civil, with electrical experience, college, shops, drawing offices; A.M.I.C.E. exam.; good references; moderate salary.—Address, 1942, Engineer Office, 33, Norfolk-street, Strand, W.C. 1942

Engineer (Age 22), having served five years in a general engineers, also just finished technical training, SEEKS ENGAGEMENT.—Apply, P. F., 376, York-road, Islington, London, N. 1937

Engineer (22), Mechanical and Electrical, 3 years college, 2 years workshop, and fifteen months sea service, REQUIRES POSITION as ASSISTANT; home or abroad.—Address, 1911, Engineer Office, 33, Norfolk-street, Strand, W.C. 1911

To Manufacturers. — Engineer, Surveyor, or Works Manager (40) will be OPEN to TAKE UP an ENGAGEMENT in about three months; electric, refrigerating, hydraulic, locomotive, and general engineering experience; a thorough knowledge of all building trades, including designing, taking off quantities, and inspection of works. Works manager eleven years. Good references.—Address, 1908, Engineer Office, 33, Norfolk-street, Strand, W.C. 1908

Engineering Pupil. — Firm (Government Contractors), employing 500 hands, have VACANCY; varied classes of work done, affording excellent opportunities; premium moderate.—Address, 161, Engineer Office, 33, Norfolk-street, Strand, W.C. 161

An Exceptional Opportunity offers to anyone having a thorough practical experience in the Construction of Light Draught Boats and Machinery for same to JOIN ANOTHER in EXISTING WORKS and established business; moderate capital required.—Address, 1648, Engineer Office, 33, Norfolk-street, Strand, W.C. 1648

Burys and Co., Limited, Regent WORKS, SHEFFIELD.—FOR SALE, a NUMBER of £10 SHARES of this Company fully paid. Average dividends for the last five years £5 14s. per cent. Offers to be addressed to Messrs. RONALD and RITCHIE, S.S.C., 20, Hill-street, Edinburgh. 2145

Constructional Engineer, Well- KNOWN Specialist and Writer, establishing himself in the Midlands, DESIRES CORRESPOND LONDON CONSULTING FIRM, view to co-operation or assistance in their constructional work. Exceptional experience continental, American, and home practice. Prepared undertake sole responsibility. Designs; specifications; inspection. Strictest confidence.—Address, P885, Engineer Office, 33, Norfolk-street, Strand, W.C. P885

Partner Wanted in Engineering, Steam Haulage, &c., business: South of England, easy reach of London; half share only £750; present owner's hands 20 years; plenty of work at good prices.—Apply, BROMHEAD and CO., Engineers' Valuers, 33, Cannon-street, London, and 121, Colmore-row, Birmingham. 2036

Partnership Wanted in Suc- CESSFUL Modern Engineering Business by young Practical Engineer. Can invest up to £10,000.—Address, in confidence, to 2050, Engineer Office, 33, Norfolk-street, Strand, W.C. 2050

Thirty Miles from London on a MAIN LINE OF RAILWAY.—A Firm of Engineers, having a works larger than their business requires, would ENTERTAIN a PARTNERSHIP with a PRACTICAL MAN who can bring in some Capital and Work. None but principals need apply.—In first instance address, X. Y. Z., care of Hannaford and Hodges, Ltd., Advertising Agents, 57, Ludgate-hill, London. 1952

Wort and Beadle, Naval Architects and Consulting Engineers, Cowes, I.W. Designers of 19-knot 20ft. launch "Durendal." Surveys, Estimates, Specifications, Designs, and Expert Assistance of every kind relating to Marine Motor Engineering.
Telephone No. 0470a. Telegrams: "Consult, Cowes." Y993

Completion of Kew Bridge.— FOR SALE, a quantity of CONTRACTOR'S PLANT and MATERIALS, comprising a suspension cableway, one 10-ton steam derrick crane, with bogies; one 1-ton hand derrick crane; one 30-cwt. ditto; one 10-ton overhead traveller; one Adie cement tester; rock grab, barges, mortar mill, tip wagons, vertical boiler, chains, &c.; and pitch pine logs, 12in. to 14in. square; ditto, half timbers, &c.—Apply, CONTRACTORS' OFFICE, Kew. 1775

Wanted, for Lifting 750 Gallons per minute from a depth of 154 yards, ONE 70 cyl. CORNISH ENGINE; TWO LANCS. or CORNISH BOILERS, 24ft. by 7ft.; and new Pit Work complete, 20in. Pipes, two Lifts, 77 yards each.—Address, for the whole or part, to JOHN WILLIAMS and CO., Dorothea Office, Carnarvon. 2060

Wanted, Good Second-hand C.S.C. VERTICAL ENGINE, cyls. about 10in. and 16in. by 12in. stroke, complete with air and circulating and bilge pumps.—Address, P826, Engineer Office, 33, Norfolk-street, Strand, W.C. P826

Condensing Plant. — Wheeler COMBINED OUTFIT, 250ft. cooling surface, 6in. steam 6in. air, 8in. water cylinders × 7in. stroke; practically new; cheap.—POLLOCK BROWN and CO., Southampton. A326

For Hire, Pumps and Well- BORING TOOLS for Contractors, Deep Wells, &c., 3in. to 24in. diam.—R. RICHARDS and CO., Upper Ground-street, London, S.E. Telephone No: 978 Hop. 822

For Sale.—
Pair Self-contained Double-ended SHEARS (by Buckton), 6in. cyl., 12in. stroke.
New Double-ended PUNCHING and SHEARING MACHINE, and with angle shears to punch and shear ⅜in. × ⅜in.
Self-contained CUTTING DOWN SHEARS, horl. engine, about 8½in. × 20in.
Set Self-contained BAR SHEARS, 12in. cyl., 12in. stroke.
Hill's Patent Flush Side Swivelling Head SAWING MACHINE.
4-cwt. PNEUMATIC HAMMER.
3-cwt. Ditto.
Motor-driven S. S. and S.C. LATHE, to swing 22in., between centres 8ft. 10in.
Morgan BOLT-SCREWING MACHINE (threads cut Whitworth 1in. to 3in.)
36in. Triple-geared Slide, Surface, and Boring LATHE.
30in. Ditto, ditto.
Machinery let out on hire or sold on purchase hire.
Illustrated Catalogues post free.

THOS. W. WARD,
ALBION WORKS, SHEFFIELD.
Telegraphic Address: "Forward, Sheffield." 6121

For Sale:—
3ft. 6in. RADIAL DRILLING & TAPPING MACHINE
5ft. 6in. do. do. do. do.
7ft. do. do. do. do.
Apply, CAMPBELLS and HUNTER, Limited, Dolphin Foundry, Leeds. 61

For Sale:—Compound Vertical, Inverted ENGINE, massive pattern, cylinders 12in. and 20in. by 20in. stroke.
Vertical Inverted high-pressure ENGINE, cylinder 12in. by 12in. stroke.
GAS ENGINE, ¼ to 16 H.P. nominal; good order.
Pair of Duplex Compound PUMPING ENGINES, capacity 20,000 gallons per hour; second-hand.

FIELDING AND PLATT, LIMITED,
GLOUCESTER. Y344

For Sale, Dry-back Marine or "Economic" BOILER, 15ft. by 9ft., 160 lb. w.p.; fittings complete; ready for immediate delivery.—H. and T. DANKS, Limited, Netherton, Dudley. 153

For Sale.—Fine Pair Horizontal Fly-wheel PUMPING ENGINES, 16in. steam cyls., 6in. double-acting brass-lined pumps, 12in. stroke, suitable for 300 to 400ft. head. Horizontal Cylinder Boring Mill, 8-A. bar, 6in. by 11ft. long. Worthington Type Horizontal Duplex Pumps, 6 by 4 by 6in. stroke; 6½ by 4½ by 6in. Vertical Ditto, &c.—JOHNSON, Sumner-lane, Barnsley. Y800

For Sale, New Steel Lancashire BOILERS, ready for immediate delivery:—
Six 30ft. × 8ft. dia., for 100 lb. working pressure.
Two 30ft. × 8ft. dia., for 160 lb. ditto.
Six 30ft. × 8ft. dia., for 120 lb. ditto.
Other sizes in progress.

SPURR, INMAN AND CO., LIMITED,
Calder Vale Boiler Works, Wakefield. X1670

For Sale, One Pair of Double- ACTING HORIZONTAL MUMFORD PUMPS. Steam cylinder diameter 12in.; pump chambers diameter 11½in.; stroke about 14in. Pumping capacity 400 gallons per minute.

All in good order, with straight-way valves on suction and delivery pipes, and air vessel of large capacity. Working at steam pressure of 145 lb.

Address, 1941, Engineer Office, 33, Norfolk-street, Strand, W.C. 1941

For Sale, One 5½-Ton Steam FORGE HAMMER, one 18 H.P. GAS ENGINE, one SLITTING and PLANING MACHINE, one set of Wright's FEED and PURIFIER MACHINES, capacity 7000 gallons per hour.—JAMES W. ELLIS and CO., Newcastle-on-Tyne. 1932

For Sale or Hire:—
PORTABLE ENGINES, 6 to 30 N.H.P.
SEMI-PORTABLE ENGINES, 12 to 50 N.H.P.
TRACTION ENGINES, 5 to 10 N.H.P.
PLOUGHING ENGINES and Implements.
CENTRIFUGAL PUMPS.
SAW BENCHES and SAWS.
Immediate delivery from works for breakdowns, &c.

HENRY LEWIS AND SONS,
ENGINEERS, READING. TT13
Telegrams: "Lewis, Reading." Full list free.

For Sale, Powerful Vertical MILLING and SLOT-DRILLING MACHINE, in condition equal to new; spindle 2½in. dia., by Sharp, Stewart and Co.—I. COHEN and CO., 240, Blackfriars-road, London, S.E. 1926

For Sale, Punching and Shearing MACHINES, double and single-ended. Large stock.—HY. GITTUS, Midland Ironworks, Travis-street, Manchester. A10

For Sale, Radial Drilling Machine, 4ft. 6in. arm, cut gear, balanced spindle, box table, &c.—I. COHEN and CO., 240, Blackfriars-road, London, S.E. 2071

For continuation of Small Advertisements see pages II., III., *and* LXVI.

*** *Index to Advertisements page* LXV.

ALEX. WILSON,

ENGINEER,
172, FENCHURCH-STREET, LONDON, E.C.
Formerly of the Vauxhall Ironworks.
Telegraphic Address: "Ingenieur, London."
Telephone No.: 1908 Central.

LAUNCH AND MARINE ENGINES FOR SALE:—

One C.S.C.	6in.	by 12in.	by 8in. stroke.
Two C.S.C.	8in.	by 16in.	by 10in. stroke.
One non-condensing	8¼in.	by 14½in.	by 10in. stroke.
One C.S.C.	9in.	by 18in.	by 14in. stroke.

ALSO Y1051

COMPLETE LAUNCHES, BOILERS, PUMPS, &c.

Cranes (ALL TYPES AND POWERS).
See Displayed Advertisement and "Appleby's Hand-book of Machinery."—JESSOP and APPLEBY BROS. (Leicester and London), Limited, 22, Walbrook, London, E.C. (Spl) 4030a

---

For PROMPT SALE
AT VERY LOW PRICES.

The following GOODS are for IMMEDIATE DISPOSAL, and at the prices affixed they are an exceptional bargain:—
Plate Edge-PLANING MACHINE, to plane plates 18ft. 6in. wide; reversing gear, down-feed, turn-over tool box; by Shepherd, Hill and Co. 4130.
100ft. of best turned STEEL SHAFTING, with couplings and column bearings, from 3½in. to 6in. diameter; on rail Nottingham, £9 10s. per ton.
Pair Raworth's Patent Quadruple-expansion TWIN ENGINES, 300 H.P.; not done 6 months' work. 4126.
One extra strong 20in. Stroke SLOTTER, £130.
One Powerful 14½in. Stroke Do., £95.
One 14in. Stroke Self-acting SHAPER, 2 Tables, £55.
Powerful Engine-driven SCRAP SHEARS, cuts equal 80 lb. rails, £80.
Powerful RADIAL DRILL, 14ft. radius, standard 16ft. high; spindle, 6¼in. diam.; weight about 20 tons. £220.
25in. Centre Treble-geared Self-acting BREAK LATHE, face-plate 7ft. diameter; will admit in pit 14ft. diameter, loose bed 15ft. 6in. long; strong modern tool; to be sold, cheap.
Powerful 30in. Stroke Modern SLOTTING MACHINE, by Hulse; very massive tool; perfect order.
Very heavy Triple-geared, Self-acting LATHE with 9ft. face plate; will admit 11ft. dia.; splendid tool, by Hulse.
20 N.H.P. (48 I.H.P.) "Otto" Horizontal GAS ENGINE; specially overloaded; £160.
40 N.H.P. (96 I.H.P.) Ditto; £230.
Very powerful Vertical Screw-driven PLANING MACHINE; 8ft. vertical and 7ft. longitudinal traverse; £135.
Screw-driven PLANING MACHINE, by Whitworth, to plane 20ft. by 4ft. 6in. by 4ft. 6in.
TWO 50 H.P. Loco. type BOILERS.

For appointments to inspect and full information apply—
LEE & HUNT,
Crocus Street, NOTTINGHAM. Q378

For Sale, Range of Four Lancashire BOILERS, 30ft. by 8ft., Hopkinson's fittings; working under insurance 93 lb. pressure.—R. H. LONGBOTHAM and CO., Wakefield. 1611

For Sale, Slotting Machine, 8in. stroke, by Shepherd, Hill and Co.; in first-class condition.—I. COHEN and CO., 240, Blackfriars-road, London, S.E. 1207

For Sale, Three 20 Nom. H.P. Marshall Horizontal Compound ENGINES and THREE 30 H.P. Marshall Multitubular High-pressure BOILERS, with feed-water heater; TWO Worthington PUMPS, 5in. ring steam mains, 7in. exhaust, water tanks, &c. In good working order.—The plant may be inspected on application to the CLERK to the GOVERNORS, People's Palace, Mile End-road, E. 2051

For Sale, Tip Wagons.—Seven TWO-YARD WAGONS, tip either side, steel bodies and under-carriage; just off a job; in first-class order; 2ft. 6in. gauge; a low price to clear.—FLOWER and EVERETT, 69, King William-street, E.C. 1634

For Sale, Two Vertical Compound STEAM PUMPS, 12in. and 20in. by 22in. by 18in. stroke, c.i. air vessel, &c., by Blake and Knowles; practically new.—R. H. LONGBOTHAM and CO., Wakefield. 1612

For Sale, Vertical Drilling MACHINE, to admit 48in. dia., on table, by Shepherd, Hill and Co.; balanced spindle 2½in. diameter, 12in. S.A. feed; in first-class condition.—I. COHEN and CO., 240, Blackfriars-road, London, S.E. 1205

For Sale, 13in. × 20in. 6-Wheels coupled SADDLE TANK LOCOMOTIVE, being re-built, new copper fire-box, &c. Also 14in. × 20in. 6-wheels coupled SADDLE TANK LOCOMOTIVE, being re-built, new boiler, &c. Both equal to new.—THE AVONSIDE ENGINE CO., Bristol. Y949

High-class Machine Tools Ready FOR IMMEDIATE DELIVERY.
Double-ended Double-geared PUNCHING and SHEARING MACHINE, with angle shears, to punch and shear 11in. × 11in. × 24in.
Double-ended double-geared PUNCHING and SHEARING MACHINE, to punch and shear ⅞in. × ⅞in. × 20in.
Double-ended double-geared PUNCHING and SHEARING MACHINE, to punch 1in. × 1in. × 24in., shear 1in. × 18in. (shear at angle for cutting long bars).
12in. and 16in. Stroke SLOTTING MACHINES.
6ft. BENDING ROLLS.
FRANCIS BERRY and SONS, Sowerby Bridge. 1156

Hire! Hire! Hire!
STEAM CRANES, STEAM AND GAS ENGINES, MORTAR MILLS, HOISTS, BRICK CRUSHERS, TRACTION ENGINE, &c., for SALE or HIRE at Moderate Prices
Repairs and Castings.
LEWIS AND LEWIS, LIMITED,
Engineers and Ironfounders,
THE FOUNDRY, TOWNMEAD-ROAD, FULHAM,
LONDON, S.W. Y989
Telegrams: "Lewises, London. Telephone: 552 Kensington

Lancashire Boilers Ready for IMMEDIATE DELIVERY.
Two 30ft. × 8ft. 6in., 160 lb. pressure.
Three 30ft. × 8ft., 100 lb. pressure.
One 28ft. × 7ft., 100 lb. pressure.
Detailed specification forwarded on application.
Apply—
OLDHAM BOILER WORKS CO., LTD.,
OLDHAM. 178

Locomotives in Stock:—

One 6in. cylinder		2ft. gauge.
One 7in.	"	2ft. gauge.
One 7in.	"	2ft. 6in. gauge.
One 8in.	"	3ft. gauge, ready.
One 10in.	"	4ft. 8½in. gauge, ready.
One 12in.	"	4ft. 8½in. gauge, nearly ready.
One 16in.	"	4ft. 8½in. gauge, nearly ready.

One TURNTABLE for 20 tons; 18ft. diameter, for 4ft. 8½in. gauge.
Two TURNTABLES, self-contained, 6ft. dia., 2ft. gauge, boarded top, to carry 6 tons.—W. G. BAGNALL, Ltd., Castle Engine Works, Stafford. 1209

LOCOMOTIVES IN STOCK.
KERR, STUART & CO., LTD.,
have in stock, or in an advanced state of progress, at their California Works, Stoke-on-Trent, a large number of
LOCOMOTIVES,
with cylinders from 6in. to 18in. diameter (inclusive), for all gauges from 18in. to 4ft. 8½in.—Apply to KERR, STUART and CO., Ltd., 22, Bucklersbury, E.C. 993

The Cycles of Gas and Oil ENGINES. By JAMES D. ROOTS, M.I.M.E. Demy 8vo., with numerous Illustrations. Price 4s. 6d., post free 4s. 10d.

"Mr. Roots is so well known as an authority upon this subject that a volume of this work will be eagerly welcomed, not only by engineers generally, but more especially by those who conscious of the defects of the spirit motor for automobile purposes, waste time and money in bringing out a new motor. —*The Automotor and Horseless Vehicle Journal.*

Smoke and its Diminution. By BRYAN DONKIN, M.I.C.E., M.I.M.E., &c. A reprint of important articles on this momentous question. Price 6d. net, post free 7d.

The Tower Bridge: Its History and Construction. By J. E. TUIT, M. Inst. C.E. Illustrated by C. W. Wyllie and others. Demy 4to., cloth, gilt lettered, 6s.; by post, 6s. 4½d.

H.M.S. Victory: Her History and Construction. By Capt. C. ORDE BROWNE R.A. (Retired), and H. J. WEBB. Price 6d., post free 7½d.

The Preparation of Parliamentary PLANS FOR RAILWAYS. By HARNETT JOHN FULLER, C.E. Demy 8vo., 2s. 6d. net, post free 2s. 8d.

"THE ENGINEER" OFFICE,
33, NORFOLK STREET, STRAND, W.C.

Farnley Iron
("Best Yorkshire")
The Farnley Iron Co., Ld. Leeds
4186

STEVENSON'S METAL Co.
MOORSOM STREET METAL WORKS,
TRADE "SILVO" MARK. BIRMINGHAM.
MANGANESE BRONZE, Tensile 36 tons per square inch. Elongation 28 per cent. in 2in.
Rods, Bars, Billets, Forgings, &c., to Admiralty requirements.
WHITE METAL TUBES (non-corrosive),
Seamless and Brazed in round, square, and ornamental.
BOILER STAY RODS. Prompt Delivery.
Telegrams—DUCTILE, BIRMINGHAM. (Spl) 4193

Manchester Steam Users' Association
For the Prevention of Boiler Explosions,
9, MOUNT STREET, MANCHESTER.
Chief Engineer—C. E. Stromeyer, M.I.C.E.
Founded 1854 by Sir W. Fairbairn. Certificates of Safety issued under the Factory and Workshops Act, 1901. Compensation for Damages and Liabilities paid in case of Explosions. Engines and Boilers designed and inspected during construction. Spl. 4174

HARPERS' LIST.
PAGES XIV.—XV.
THREE WEEKS AGO.

West Pascagoula Creosoting Works,
WEST PASCAGOULA, MISS., U.S.A.
Situated on Pascagoula Bay and on the line of the Louisville and Nashville Railroad. These works have been in operation for more than twenty-six years. ORDERS for Creosoted Piles, Telegraph Poles, Cross Arms, Electric Conduits, Paving Blocks, Sawed Ties and Timber PROMPTLY EXECUTED. New cylinders, 115ft. long. Capacity, one million feet per month. A.B.C. code used. Cable address: Pierre, West Pascagoula, Miss.—Address, JNO. B LINDSEY, Superintendent. (Spl) 4178

FOR ABSOLUTELY UNEQUALLED EFFICIENCY.

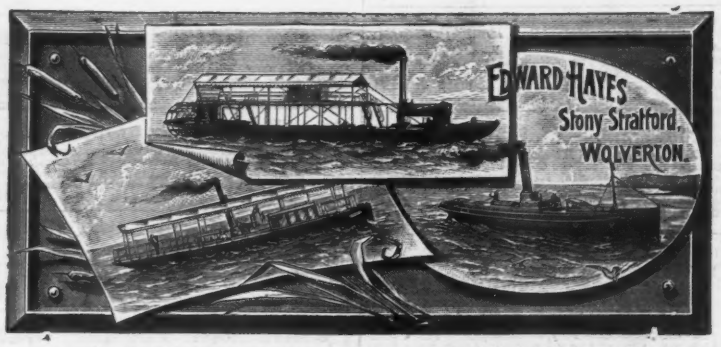
THE BAKER OIL SEPARATOR
For EXHAUST STEAM.

High Efficiency, Perfectly Automatic and Continuous.

THE BEISSEL WATER SOFTENER

Catalogues may be had on application to C2194

BAKER'S Patent Appliances Co., Ltd., **SCARBOROUGH.**



Vessels can go abroad in pieces or whole 40ft. to 70ft. long. Stern-wheelers 80ft. to 120ft. in pieces.

HIGH-PRESSURE or COMPOUND SURFACE-CONDENSING ENGINES and BOILERS.
Supplied separately if required. TELEPHONE—2899 AVENUE.
MAKER TO THE ADMIRALTY, EGYPTIAN, & SOUTH AMERICAN GOVERNMENTS, &c. B16

THE
Vulcan Boiler and General Insurance
COMPANY, LIMITED.
Chief Offices: 67, KING STREET, MANCHESTER.
ESTABLISHED 1859.
Subscribed Capital - - £375,000.

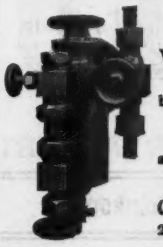
INSURANCE AND INSPECTION OF BOILERS, ENGINES, DYNAMOS MOTORS, AND OTHER ELECTRICAL PLANT.

Over 48,000 Boilers and Engines under supervision.

WORKMEN'S COMPENSATION ACT, Employers' Liability Act and Common Law, PERSONAL ACCIDENT, THIRD PARTY, FIDELITY GUARANTEE, and BURGLARY INSURANCE.

Application for Agencies invited. W1903

Locomotive Sight-Feed Lubricator.



WAKEFIELD'S Patent.
No Stoppage when glass breaks.
No variation in feed.
In use on over 40 British and Foreign Railways.
MADE AND SUPPLIED ONLY BY
C. C. WAKEFIELD & CO.,
27, CANNON ST., LONDON, E.C. 415

CRAVENS LIMITED,
RAILWAY CARRIAGE & WAGON WORKS
DARNALL, NEAR SHEFFIELD,
Manufacturers of
Every Description of RAILWAY CARRIAGES, WAGONS TRAMCARS, IRONWORK, WHEELS, and AXLES, BRASS and IRON CASTINGS, &c.
Wagons built for cash or for Deferred Payments.
Prices and Specifications on Application. 437

Darlington Wagon & Engineering Co.
LIMITED.
MAKERS of RAILWAY WHEELS and AXLES, RAILWAY WAGON IRONWORK, BUFFERS, CASTINGS, RAILWAY WAGONS for CASH, DEFERRED PAYMENTS, or HIRE, BRIDGES, GIRDERS, ROOFS, &c.
TANK WAGONS a SPECIALITY.
Offices and Works:—DARLINGTON.
Suffolk House, Laurence Fountney Hill, Cannon Street, London, E.C. Q678
Telegrams—Wagon, Darlington; Girders, London.

THE
ELECTRIC RAILWAY & TRAMWAY CARRIAGE
WORKS, LTD., PRESTON, LANCS.
Manufacturers of
RAILWAY CARRIAGES, TRAMCARS for ELECTRIC TRACTION, and all kinds of ROLLING STOCK for LIGHT RAILWAYS. Q497a
Registered Office and Works—Strand-road, Preston, Lancs.

THE GLASGOW RAILWAY ENGINEERING COMPANY, Ld., GOVAN, GLASGOW.
London Office—13, VICTORIA STREET, S.W.
MANUFACTURERS OF RAILWAY WHEELS AND AXLES OF EVERY DESCRIPTION.
Every kind of Smith Work, also CAST STEEL AXLE BOXES. Q402

RAILWAY & TRAMWAY SPRINGS
to British, Colonial, India Office Specifications, &c.
W. GRIFFITH & SONS,
Sheffield.
Napier Steel and Spring Works and Providence Works.
London Offices:
Palace Chambers, 9, Bridge-street, Westminster, S.W.
Telegraphic Address: Griffith, Sheffield.
National Telephone No. 846. 893

ESTABLISHED 1861.
HARRISON & CAMM, Ld.
Chief Works and Offices—ROTHERHAM.
Manufacturers of
WHEELS & AXLES
with Cast or Hydraulic forged naves,
Wagon Ironwork, Castings, RAILWAY WAGONS (in Iron, Steel, or Timber). 491

SALE.
MESSRS. CHAPMAN AND FURNEAUX (Late BLACK HAWTHORN AND CO.)
R. and W. Hawthorn, Leslie
AND CO., LIMITED,
FORTH BANKS LOCOMOTIVE WORKS, NEWCASTLE-ON-TYNE,
Having Purchased from Messrs. Chapman and Furneaux (late Black, Hawthorn and Co.) the whole of the Patterns, Drawings Goodwill, &c., of their Locomotive Business, will have pleasure in TENDERING for DUPLICATE PARTS and REPAIRS, or NEW ENGINES when required. 154

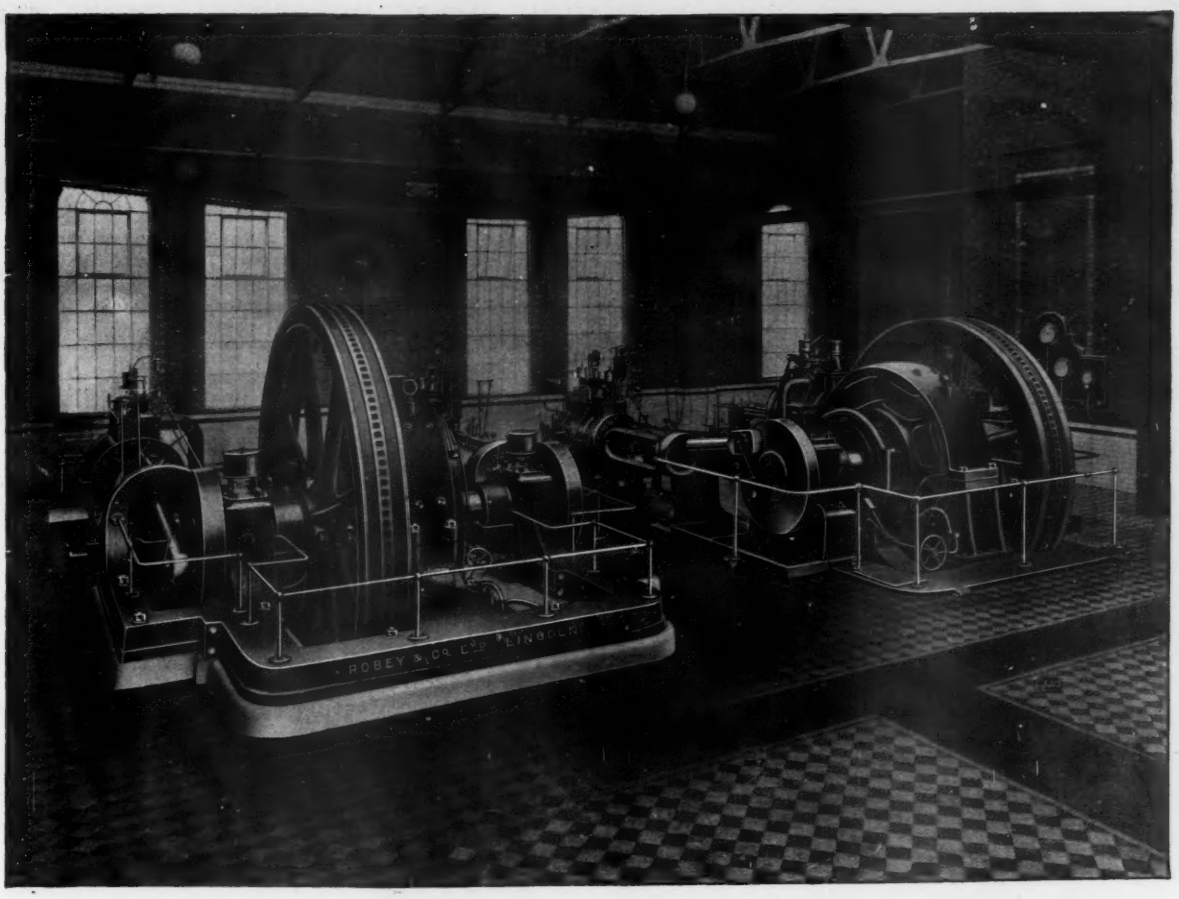
MIDLAND
RAILWAY CARRIAGE & WAGON Co., Ld.
MIDLAND WORKS, BIRMINGHAM,
AND
ABBEY WORKS, SHREWSBURY.
RAILWAY CARRIAGES, RAILWAY WAGONS, TRAMCARS, &c. &c.
LONDON OFFICES— 482
SUFFOLK HOUSE, LAURENCE POUNTNEY HILL, E.C.

P. & W. MACLELLAN, LTD.,
CLUTHA WORKS, GLASGOW.
Manufacturers of RAILWAY WAGONS and CARRIAGES, IRON and STEEL SLEEPERS, FISH BOLTS, SPIKES, and other PERMANENT WAY MATERIAL, BRIDGES, and ROOFING.
CONTRACTORS for RAILWAY PLANT and STORES of every description.
Chief Offices—128, Trongate, Glasgow. 661
Registered Offices—3, Great Winchester Street, London, E.C.

W. R. RENSHAW & CO.
LIMITED.
Railway Carriages, Wagons, and Tramcars.
Steel or Wood Underframes and Bodies.
Cars for Electric and Light Railways. Wagon Ironwork. Iron or Brass Castings. Wheels and Axles. Wagons built for cash, or on 3, 5, or 7 years' deferred payments. 496
PHŒNIX RAILWAY WORKS & WAGON WORKS, STOKE-ON-TRENT.

G. R. TURNER, Ld.
Manufacturers of all descriptions of
IRON & WOOD FRAME WAGONS
For Home, Colonial, & Foreign Railways.
Wheels & Axles, Ironwork, Iron & Brass Castings,
PERMANENT WAY MATERIALS, &c.
Chief Works & Offices: Langley Mill, nr. Nottingham

ROBEY & CO., LD GLOBE WORKS, LINCOLN

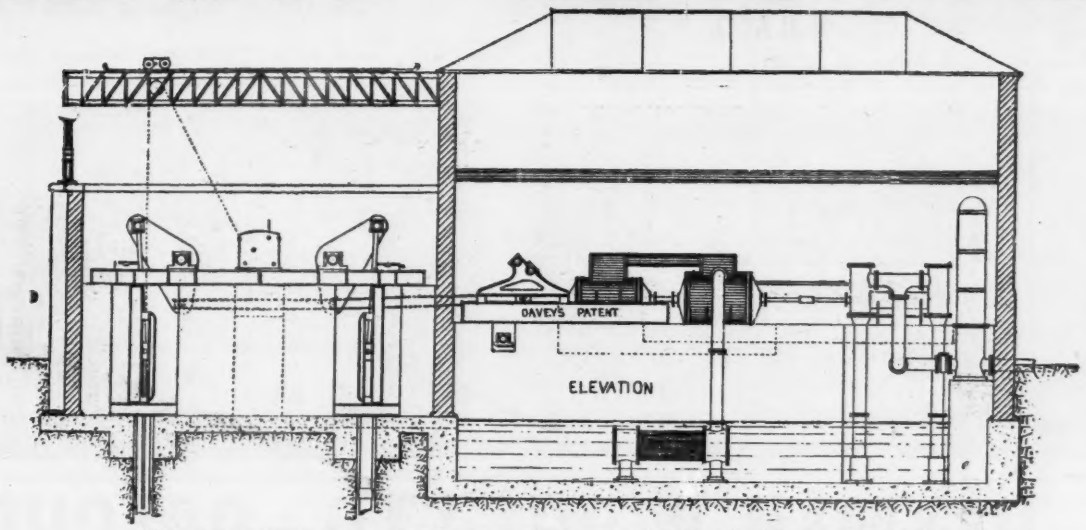


Installation of Coupled Compound Horizontal Fixed Engines, Fitted with Patent Trip Expansion Gear.

London Offices and Showrooms: 79, QUEEN VICTORIA ST., E.C. Branches & Agencies in all parts of the world

PUMPING MACHINERY

FOR WATER WORKS AND MINES.



COMPOUND HIGH DUTY BORE HOLE PUMPING ENGINE, WIDNES WATERWORKS. N936

CAPITAL COST OF INSTALLATION,

INCLUDING BOREHOLES, FOUNDATIONS, ENGINES, PUMPS, AND BUILDINGS,

£9975, OR 2½ PENCE PER 1000 GALLONS PUMPED PER ANNUM.

Telegrams—HATHORN, LEEDS.

HATHORN, DAVEY & CO., LTD., LEEDS

HADFIELD'S

STEEL FOUNDRY CO., Ld,

SHEFFIELD.

HADFIELD'S PATENT 'ERA' MANGANESE STEEL

IS THE SUPREME MATERIAL FOR THE

WEARING PARTS OF ORE-CRUSHING MACHINERY,

TRAMWAY POINTS, CROSSINGS, etc.

STEEL
DYNAMO CASTINGS
GIVING HIGHEST PERMEABILITY RESULTS.

STEEL CASTINGS & FORGINGS

JOHN BIRCH & CO., LTD.

3, LONDON WALL BUILDINGS, LONDON WALL, LONDON, E.C.

Telegraphic Address—"ENDEAVOUR, LONDON."

Purchase, Inspect, and Ship Material and Machinery for Engineers and Contractors abroad, and act as Home Agents for Foreign Dockyards, Arsenals, Railways, Engineering Shops, Foundries, &c.

Estimates, Plans, and Specifications submitted for all classes of Machine Tools, Machinery, Sea-going and River Steamers, Barges, Dredgers. Rails and Rolling Stock provided to Main Lines.

Planters and Contractors supplied with Medium, Light, and Portable Railways complete.

CORRESPONDENCE INVITED.

Monthly Prices Current of Engineering Material mailed free on application.

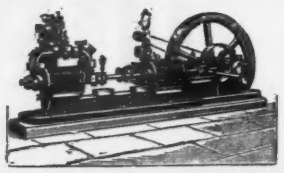
Telegraph Codes used:—Our own Private Code and 12 others. (Spl) BM 62

ICE-MAKING AND REFRIGERATION

Over 5400 Machines Sold on Linde and Lightfoot Systems.

AMMONIA. CARBONIC ACID.

For use on Land and Board Ship.



THE
LINDE BRITISH REFRIGERATION CO., Ld.

35, Queen Victoria Street, London, E.C.

(Spl) xxiii

Telephone—No. {5841 / 5842} BANK. Telegraphic Address—SEPARATOR, LONDON

Lilleshall Company

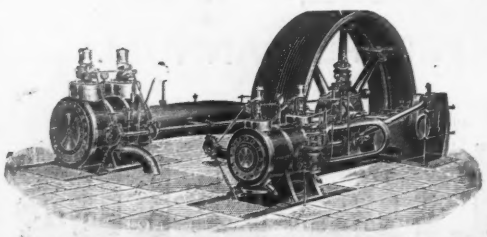
ENQUIRIES TO THE LONDON OFFICE—
THE LILLESHALL COMPANY Ltd
71, Finsbury Pavement, E.C.

ENGINE WORKS
Oakengates,
SHROPSHIRE.

make PUMPING ENGINES
BLOWING ENGINES

DAVEY, PAXMAN & CO., LTD., COLCHESTER

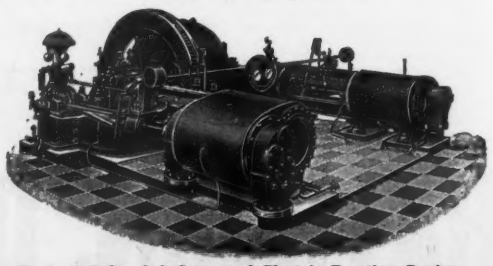
Speciality: ENGINES & BOILERS FOR ALL PURPOSES.



Latest Design Horizontal Coupled Compound Engine, fitted with Paxman's Patent Drop Valve Gear.

Paxman "Economic" Boilers.
Paxman's Patent Independently-fired Superheaters.
Paxman's Patent Condensing Plants.
Compound and Simple Portable and Semi-fixed Engines. Air-compressing, Winding & Pumping Engines.

London Office:
78, QUEEN VICTORIA ST., E.C.



Horizontal Coupled Compound Electric Traction Engine. Paxman's Patent Heavy Service Type. (Spl xxv5

INDEX TO ADVERTISEMENTS.

Advertisements not appearing this week, but included in the "Subject Matter Index," will be found by reference to the preceding or following issues, with the exception of those appearing monthly

PAGE

Acme Lathe & Products Co 41
Aird, J. 65
Akrill, C., and Co., Ld 4
Alexander, E. P., and Son 3
Allen, Edgar, and Co 36
Alley and Maclellan 4
Alliance Assurance Co., Ld 6
American Locomotive Co 5
Archdale, J., and Co 48
Armstrong, J., & Co., Ld 61
Armstrong, Stevens & Son 5
Armstrong, Whitworth & Co., Ld 54
Atnil's Bridge & Roof Co., Ld 58
Asbestos Co., Bell's 2
Asbestos Engine Co 20
Asgnall, W. G., Ld 29
Asgshaw, J., and Sons 31, 36
Bailey, W.H. & Co 3
Baker Blower Engin'g Co 3
Baker, J., and Sons, Ld 3
Baker's Pat. Appliances Co 3
Barnett and Foster 6
Baxter, W. H., Ld 66
Bayliss, Jones & Bayliss, Ld 28
Beardmore, W., and Co 62
Beardmore, W., and Co 35
Beatson and Sons 51
Bedford Engineering Co 53
Bemrose and Sons, Ld 4
Bennett and Sayer 6
Best Belting Co 63
Beyer, Peacock and Co., Ld 22
Birch, G., and Co 4
Birch, J., and Co., Ld 34
Birmham Battery & Metal Co 12
Blackstone and Co 45
Blakstone and Co 33
Blake & Knowles' Pump W'ks 8
Boby, R. 65
Boby, W. 45
Bolling and Lowe 25
Bourne Drying & Vent'g Co 35
Boyle, Robt., and Son 3
Brady, F., and Co 8
Brackett, F. W., & Co 63
Bradley Pulverizer Co., Ld 4
Bradley Pulverizer Co., Ld 55
Brett's Stamping Co., Ld 66
Britannia Co 4
British Insulated & Helsby Cables, Ld 25
Brit's Steam Specialities, Ld 6
Brit. Westinghouse Elec Co 37
Broughton Copper Co 64
Brown, D., and Sons 62
Brown, J., & Co., Ld., Sheff'd 18

PAGE

Buck and Hickman, Ld 61
Buckley and Taylor, Ld 4
Buckton, J., and Co., Ld 12
Bull's Metal & Melloid Co., Ld 35
Bumsted and Chandler 41
Burley and Son, Ld 4
Burnham, Williams and Co 55
Burrell, C., and Sons, Ld 41
Butterley Company, Ld 48
Butterworth Bros., Ld 55
Campbell Gas Engine Co. Ld 13
Campbells and Hunter 6
Carbro'k Steel Works 53
Carr and Nichols, Ld 57
Carruthers, J. H., and Co 57
Central Marine Engine Wks 45
Chambers, Scott and Co 40
Chaplin, A., and Co 42
Churchill, C., and Co 3
Clarke, Chapman & Co., Ld 50
Clarke's Crank and Forge Co 22
Clay Cross Co 38
Cochran & Co., Annan, Ld 35
Cooker Bros., Ld 43
Cohen, I., and Co 54
Colt's, Marchent and Morley Ld 64
Coltman, H., 52
Coltman, H., and Sons 60
Combe Barbour, Ld 47
Consolidated Eng. Co., Ld 55
Consolidated Pneumatic Tool Co., Ld 22
Conveyor and Elevator Co 11
Cook and Hammond 66
Cradock, G., and Co 33
Cravens, Limited 55
Cresswell's Asbestos Co., Ld 6
Crosby Steam Gage & Valve Co 52
Crossley, Geo., Ld 41
Crowther, H., and Sons, Ld 57
Cruse Superh ater Co 30
Cundall, R., and Sons, Ld 4
Cunliffe and Croom, Ld 40
Daniell, S. A., Ld 40
Darling and Sellers, Ld 27
Darlington Forge Co., Ld 13
Darlington Wagon & Eng. Co 5
Davey, Paxman & Co., Ld 31
Davidson and Co., Ld 21
Davies and Metcalfe 25
Davis Engineering Co 65
Daw, A. and Z. 19

PAGE

Dean, Smith and Grace, Ld 31
De Bergue and Co 52
Deighton's Flue & Tube Co 55
De Laval Steam Turbine Co 17
Delta Metal Co 35
Dempster, Moore & Co., Ld 62
Denison, S., and Son 61
Dick, Kerr and Co., Ld 11
Dodman, A., and Co., Ld 12
Dorman, Long and Co., Ld 60
Douglas, Lawson and Co 55
Doulton and Co 55
Dowson Economic Gas Co 38
Drum Engineering Co 5
Drysdale and Co 31
Dudbridge Ironworks, Ld 38
Earle, G. an i T. 35
East Ferry-road Engin'g Co 40
Easton and Co., Ld 35
Edwards' Air Pump Synd 66
Electric Railway Car Co 2
Elliot, G., and Co 7
Empire Engineering Co 60
Empire Roller Bearings Co 66
Erith's Engineering Co 51
Farmer, L., and Sons 6
Farnley Iron Co 2
Farrar, A. 25
Fawcett, Preston & Co., Ld 63
Ferguson Brothers 37
Fielding and Platt, Ld 1
Finch, E., and Co., Ld 11
Findlay, Alex., and Co 6
Fowler, J., and Co., Ld 51
Fuller, Horsey, Sons & Cassell 66
Galloways Limited 6
Gandy Belt Manufacturing Co 58
Gardner, L., and Sons 5
Gehrckens, C. O. 60
Gibbins, S. C., and Co 6
Gibbons Bros., Ld 30
Gilliott, J. 65
Gimson and Co., Ld 65
Glasgow Railway Eng. Co 2
Glover, M., and Co 6
Grafton and Co 3
Graham, Morton & Co., Ld 8
Grantham Crank & Iron Co 6
Greaves, W. Mc.G. 27
Green and Boulding 12
Green, T., and Son, Ld 23
Greenwood and Batley, Ld 17

PAGE

Gresham and Craven 43
Griffith, W., and Sons 2
Grieve, J., and Co 51
Grover and Co 5-12
Guilbert-Martin 45
Günther, W., and Sons 7
Gwynne's Ld 53
Hadfield's Steel Foundry Co 31
Haigh, W. B., and Co., Ld 57
Haley, E. and W. H. 60
Hall, J. P., & Sons, Ld., Peter 41
Hall, J. S. 65
Hamblet's Blue Brick Co 35
Handyside and Co., Ld 6
Hardy and Padmore, Ld 3
Hardy Patent Pick Co 65
Harpers Limited 65
Harris and Mills 35
Harrison and Camm, Ld 2
Harrison Engine Co., Ld 3
Haskew Walson Co., Ld 55
Hathorn, Davey and Co., Ld 33
Hawkins and Co., Ld 35
Hawthorn, Leslie and Co 2-65
Hayes, Edward 52
Head, Wrightson & Co., Ld 3
Heenan and Froude 28
Hemingways Ld 41
Henderson and Glass 10
Herbert, A., Ld 4
Hetherington, J., & Sons, Ld 4
Higginbottom and Mannock 56
Hill and Smith 55
Holden and Brooke, Ld 27
Hooker, P. 55
Hopkinson, J., and Co., Ld 65
Hornsby and Sons, Ld 39
Horseley Co., Ld 63
Horsfall Destructor Co., Ld 41
Howden, J., and Co 58
Howes, S. 30
Hudson Economiser Co., Ld 45
Hudson, R. 16
Hudswell, Clarke and Co 22
Hulburd Engineering Co 8
Humboldt Eng. Works Co 41
Hulse and Co., Ld 3
Hunslet Engine Co 3
Hunt, S. and Bright 66
Ince Forge 65
Industrial Engineering Co 53
Isca Foundry and Eng. Co 66

PAGE

Isles, Ld 59
Jansen and Son 2
Jessop & Appleby Bros., Ld 23
Jessop, W., & Sons, Sheffield 49
Johnson and Phillips 19-56
Jones & Lamson Machine Co 2
Jones, George, Ld 19
Kells, W. Zoon and Co 60
Kendall and Gent 29
Kenyon, W., and Sons 36
Keith and Blackman Co., Ld 45
Kerr, Stuart and Co 2
Kirk, Price and Co 55
Kirkstall Forge Co 64
Klinger, R., and Co 8-19
Körting Brothers 39
Krupp Grusonwerk, F. 7
Lancashire Dynamo Co., Ld 7
Lancaster and Tonge, Ld 54
Landenberger and Co 65
Lang, J., and Sons 6
Larmuth, T., and Co 54
Laycock, W. S. 49
Lea and Hunt 2
Leeds Eng'ng & Hydraulic Co 48
Leeds Forge Co., Ld 25
Le Grand and Sutcliff 54
Leroy, F., and Co 61
Lewis and Lewis, Ld 2
Lewis, and Sons 22
Lilleshall Co 34
Linde Brit'h Refriger'n Co. 54
Liverpool Eng. & Cond'r Co 41
Loewe Ludw., and Co., Ld 31
London Pattermmaking Wks 66
Loudon Bros 35
Lucas and Davies 3
Luke and Spencer, Ld. 39
Macdonald, J., and Son 62
Macellan, P. and W. 2
Manchester Steam Users' Ass'n 2
Marx, J., and Co 4
Mason Bros. 6
Massey, B. and S. 27
Mather and Platt, Ld 56
McCaw, Stevenson & Orr 55
McLachlan and Co 53
Measures Bros., Ld 8
Mechan and Sons 28
Meldrum Bros. 54
Mercer, R. 57
Merryweather & Sons, Ld 57

PAGE

Messer and Thorpe 35
Midland Manuf'ng Co., Ld. 59
Midland Rly. Car. & Wagon Co 2
Midsley and Sutcliffe 59
Mitchell's Emery Wheel Co. 61
M'Neil, C., jun. 22
Mond Nickel Co., Ld 40
Morton, F., and Co 37-60
Musgrave Bros. 35
Musker, C. and A., Ld. 66
National Boiler Insurance Co 62
Negretti and Zambra 2
Nelson, C., and Co. 66
Newall Engineering Co., Ld. 4
New Conveyor Co., Ld. 15
Newman, Hender & Co., Ld 66
New Sutherland Engine Co 44
Newton, Bean, and Mitchell 37
Niles-Bement-Pond Co. 60
Noakes, T., and Sons 56
Normandy's Patents 52
Oakey, J., and Sons 39
Olrik, L., and Co 7
O'Neill, S., and Sons Ld 55
Osborn, S., and Co. 52
Owen, J., and Sons, Ld 6
Owens, S., and Co. 18
Parsons, C. A., and Co. 2
Parsons' Ventilator Co. 35
Peckett and Sons 25-66
Perry, T., and Son 38
Phillips J. W and C. J. 7
Pilkington Bros., Ld 4
Pilkington, Peter, Ld 32
Pitt Machine Tool Co 65
Player, W. and J., Ld 55
Pollock, Whyte and Waddel 60
Pontifex and Wood, Ld 32
Pratt and Whitney Co 7
Premier Gas Engine Co., Ld 54
Price, J. 66
Price's Patent Candle Co 64
Priestman Bros., Ld 36
Proctor, Jas. 60
Pullan and Mann 60
Pulsometer Engin'g Co. 59
Ransomes and Rapier, Ld 11
Ransomes, Sims & Jefferies 24
Reavell and Co., Ld 33
Redfern, G. F., and Co. 35
Renshaw, W. R., and Co 7
Reveirs, G. 35

PAGE

Richards, R., and Co 1-44
Rimington Bros. 44
Robey and Co 33
Robinson, T., and Son, Ld., 14
Robinson, T. D., & Co., Ld. 65
Robson, John 42
Rogerson, J., and Co 56
Rooper and Harris, Ld. 35
Rose, Downs and Thompson 62
Ross and Duncan 40
Ross, R. G., and Son 12
Rowell, D., and Co. 5
Rowland, B. R., and Co 45
Royce Limited 17
Royles Limited 45
Russell, Geo., and Son 66
Rushworth and Livesey 6
Ryder, T., and Son 3
St. Helen's Cable Co., Ld 43
Schaffer and Budenberg, Ld 60
Schram, Harter and Co 66
Severn, W. H. 65
Shanks, T., and Co. 35
Shaw, W., and Co 42
Simons, W., and Co 7
Simpson, Strickland and Co 56
Smedley Brothers 49
Smith and Coventry 64
Smith and Grace, Ld 9
Smith, G. F., Ld 28
Smith, Henry 36
Smith, Hugh, and Co 6
Smith, John, and Co 12
Smith, T., and Sons, Rodley 44
Spencer, J., and Sons 25-66
Spon, E. and F. N. 66
Spurr, Inman and Co., Ld. 1
Stableford and Co 32
Stanley, W. F. 46
Steel Company of Scotland 57
Stern-Sonnsborn Oil Co 61
Stevenson's Metal Co 2
Stewart, D., and Co., Ld 39
Stewart and Lloyds, Ld 38-44
Stirling Boiler Co., Ld 8
Stirling Co. of U.S.A. 6
Storey, I., and Sons 35
Sun Insurance Office 7
Sutcliffe, Speakman and Co 3
Sutton, John, and Son, Ld. 35
Sykes, H. 5
Talk o'th Hill Colliery, Ld. 6

PAGE

Tangyes Limited 9
Tangye Tool & Electric Co. 14
Taylor and Challen, Ld 61
Taylor and Hubbard 57
Th rnycr ft Steam Wagon Co 15
Thorp, J. B. 66
Thwaites Brothers, Ld. 42
Timbrell & Wright Eng. Co 53
Titt, J. Wallis 12
Tomey, J., and Sons, Ld 61
Trweent, F. J. 44
Tungsten & Rare Metals Co 66
Turner, E. R. and F. 56
Turner, G. R. 2
Turton, T., and Sons 57
Unbreakable Pulley Co., Ld. 29
U.S. Metallic Packing Co 64
Valor Co., Ld 62
Vaughan and Son, London 35
Vaughan and Sin, Ld. 19
Veritys Limited 36
Vickers, Sons & Maxim, Ld 35
Vosper and Co., Ld 30
Vulcan Boiler Insurance Co 2
Vulcan Locomotive Works 23
Walles, G., and Co. 66
Wakefield, C. C., and Co 2
Walker Brothers 4
Walker Brothers, Ld 55
Ward, T. W. 1
Warner, R., and Co. 40-45
Webb and Son 44
Webster and Bennett 36
Weir, G. and J. 34
Weldless Steel Tube Co 3
Wellman Seaver Morgan Co 48
Wells, A. C., and Co 23
West Kent Portl'd Cem't Co. 5
West Pascagoula Works 2
Whitlock Brothers 45
Wiggins, F., and Sons 22
Williams, S., and Sons. 14
Wilson, Alex. 2
Wilson, John, and Son 16
Wilson, J. H., and Co., Ld. 66
Wise-Howorth, F. 66
Wood and Newland 65
Woodhouse and Rixson 58
Wootton Bros. 61
Worthington Pump Co. 6
Yarrow and Co 25-65
Youngs 60

SUBJECT MATTER OF ADVERTISEMENTS.

Agricultural Machinery:
Foster, W., and Co., Ld
Garrett and Sons, Ld
Ruston, Proctor and Co., Ld
Turner, E. R. and F., Ld

Air Compressors:
Brackett, F. W., and Co
Davey, Paxman and Co., Ld
Daw, A. and Z.
Hughes and Lancaster
Newton, Bean and Mitchell
Reavell and Co., Ld
Rotram, Harker, and Co
Scott, G., and Son, Ld
Tighman's Sand Blast Co., Ld
Walker Brothers, Wigan
Worthington Pump Co., Ld

Air Pumps:
Edwards Air Pump Synd., Ld

Arc Lamps:
Crompton and Co., Ld
Veritys Limited

Armour Plates:
Brown, J., and Co., Ld
Cammell, C., and Co., Ld
Firth, T., and Sons, Ld

Artesian Well Engineers:
Batchelor, R. D.
Isler, C., and Co
Le Grand and Sutcliff
Richards, R. and Co

Asbestos Manufacturers:
Asbestos Co., Bell's, Ld
Asbestos Co., United, Ld
Witty and Wyatt, Ld

Ash Ejector:
Trevent, F. J.

Auctioneers & Valuers:
Farmer, L., and Sons
Fuller, Horsey, Sons & Cassell
Hunt, Sons and Bright
Kirk, Price and Co
Wood and Newland

Bearings:
Empire Roller Bearings Co
Fleming, Stirkby and Goodall
Friedenhain, H. and D.

Belting:
Best Belting Co., Ld
Gandy Belt Manufacturing Co
Gehrckens, C. O.
Henley, James
Webb and Son

Blowers:
Baker Blower Engineering Co
Drum Engineering Co
Jackman, J. W., and Co
Standard Engineering Co., Ld
Samuelson and Co., Ld
Sturtevant Engineering Co

Boiler Composition:
Barony Chemical Co
Bell's Asbestos Co., Ld
Litholine Co

Boiler Covering:
Leroy, F., and Co
Tcope's Asbestos Co., Ld
United Asbestos Co., Ld

Boiler Insurance:
Manchester Steam Users Ass'n
National Boiler Insurance Co
Vulcan Boiler Insurance Co

Boiler Mountings:
Galloways Limited
Hopkinson, J., and Co., Ld
Midland Manufact'ng Co., Ld
M'Neil, C., jun.

Boilers:
Abbott and Co., Ld
Babcock and Wilcox, Ld
Central Marine Engine Works
Cochran and Co., Annan, Ld
Coltman, H., and Sons
Coltman, W. W.
Consolidated Engin'g Co., Ld
Davey, Paxman and Co., Ld
Dodman, A., Ld
Farrar, A.
Fowler, J., and Co., Ld
Galloways Limited
Grantham Crank and Iron Co
Greaves, W. McG.
Hornsby, R., and Sons, Ld
Normand's Patents
North-East n Marine Eng. Co
Olrick, L., and Co
Plenty and Son, Ld
Ransomes, Sims, and Jefferies
Rose and Duncan
Rowland, B. R., and Co., Ld
Simpson, Strickland & Co., Ld
Spencer, W. H., and Co
Stirling Boiler Co., Ld
Stirling Co. of U.S.A.
Thornycroft, J. I., and Co
Tinker, Shenton and Co
Yarrow and Co., Ld

Bolts, Nuts & Fastenings:
Acme Lathe & Products Co
Armstrong, Stevens and Son
Bayliss, Jones & Bayliss, Ld
Carr and Nichols, Ld
Hawkins and Co., Ld
Mercer, R.
Robinson, T. D., and Co., Ld

Books:
Clowes, W., and Sons, Ld
Griffin, C., and Co., Ltd
Lockwood, Crosby, and Son
Spon, E. and F. N
Whittaker and Co
Wise-Howorth, F.

Brass Founders:
Fawcett, Preston and Co., Ld
Hunter and English
Storey, I., and Sons

Brick & Tile Machinery:
Bennett and Sayer
Bradley and Craven, Ld
Pullan and Mann
Sutcliffe, Speakman & Co., Ld

Bricks:
Hamblet's Blue Brick Co., Ld

Bridges:
Arrol, Sir W., and Co., Ld
Arrol's Bridge & Roof Co., Ld
Cleveland Bridge and Eng. Co
Finch, E., and Co., Ld
Findlay, A., and Co
Handyside and Co., Ld
Heenan and Froude, Ld
Hemingways Ld
Horseley Co., Ld
Lysaght, J.
Rowell, D., and Co

Cable (Electric):
Johnson and Phillips
St. Helens Cable Co., Ld

Cable Making Mach'ry:
Wilson, J., and Son

Capstans:
Clarke, Chapman and Co., Ld

Cask Making Machinery:
Ransome, A., and Co., Ld

Castings:
Allen, E., and Co., Ld
Crossley, Geo., Ld
Darlington Forge Co., Ld
Haley, E. and W. H.
Lilleshall Co
Lloyd, F. H., and Co
Morton, F., and Co., Ld
Ransome, A., and Co., Ld
Shaw, W., and Co

Cement:
Earle, G. and T., Ld
Nelson, C., and Co
West Kent Portl'd Cement Co

Cement Machinery:
Klinger, R., and Co

Chart Holder:
Trevent, and Groom

Coal and Coke:
Ebbw Vale Steel Co., Ld
Talk o'th Hill Colliery, Ld

Coal Washing Plant:
Graham, Morton and Co., Ld
Hardy Patent Pick Co., Ld
Humboldt Eng'g Works, Ld

Condensers:
Caird and Rayner
Clarke, Chapman and Co., Ld
Cole, Marchent & Morley, Ld
Craig, A. F., and Co
Edwards' Air Pump Synd., Ld
Ledward and Beckett
Mirrlees Watson Co., Ld
Normandy's Condenser Co
Royles Limited
Wheeler Condenser & Eng. Co

Conveyors:
Conveyor and Elevator Co
Gibbons Bros., Ld
Graham, Morton and Co., Ld
Henderson, J. M., and Co
New Conveyor Co., Ld

Copying Presses:
Daniell, S. A., Ld

Cranes:
Bechem and Keetman
Booth, Jos., and Brothers
Broadbent, T., and Sons
Chambers, Scott and Co
Chaplin, A., and Co
Clarke, Chapman and Co., Ld
Coles, H. J.
Easton and Co., Ld
Fielding and Platt, Ld
Gibbins, S. C., and Co
Grafton and Co
Grieve, J., and Co
Henderson, J. M., and Co.
Higginbottom & Mannock, Ld
Isles, Ld
Jessop and Appleby Bros., Ld
Larmuth, T., and Co
Marshall, Fleming and Jack
Musker, C. and A., Ld
Ransomes and Rapier, Ld
Russell, G., and Co
Smith, Thos., and Sons
Taylor and Hubbard
Temperley Transporter Co
Vaughan and Sons, Ld
Waygood and Otis, Ld
Wilson, J. H., and Co., Ld
Wimshurst, Holliek and Co

Crucibles:
Doulton and Co., Ld

Destructors:
Horsfall Destructor Co., Ld
Meldrum Bros., Ld

Diving Apparatus:
Barnett and Foster
Siebe, Gorman and Co

Draughtsmen, Mesh.:
Messer and Thorpe

Drawings, Tracings, &c.:
Thorp, J. B.

Dredge Plant:
Ferguson Brothers
Fleming and Ferguson, Ld
Kells, K. L., W. Zoon and Co
Priestman Bros., Ld
Rose, Downs and Thompson
Simons, W., and Co., Ld
Smulders, A. F.

Driving Ropes, Hemp, &c.:
Kenyon, W., and Sons

Elevators:
Barry, Henry, and Co., Ld
Conveyor and Elevator Co
Gibbons Bros., Ld
Graham, Morton and Co., Ld
Hall, J. S.
New Conveyor Co., Ld

Emery, Emery Wheels, &c.:
London Emery Works Co
Luke and Spencer, Ld
Mitchell's Emery Wheel Co
Oakey, J., and Sons
Rooper and Harris, Ld
Rowland, B. R., and Co., Ld
Sterne, L., and Co

Evaporators:
Liverpool Eng. & Cond'r Co
Weir, G. and J., Ld

Electricity:
Allen, W. H., Son and Co
Bellias and Morcom, Ld
British Insulated and Helsby Cables, Ld
British Thomson-Houston Co
British Westinghouse Elec. Co
Bruce Peebles and Co., Ld
Crompton and Co., Ld
Dick, Kerr and Co., Ld
Fowler, J., and Co., Ld
Glimson and Co., Ld
Glamorgan Eng'g Co
Hall, J. P., and Co
Harrison Engine Co., Ld
Hartnell, W., and Co., Ld
Hulls-rubber & Teleg. Wks Co.
Industrial Engineering Co
Johnson and Phillips
Lancashire Dynamo Co., Ld
Lister Electric Manuf'g Co
Mather and Platt, Ld
Newton Electrical Works, Ld
Richardsons, Westgarth & Co
Robey and Co., Ld
Scott and Mountain, Ld
Tangye Tool and Electric Co

Engine & Boiler Fitt'gs, &c.:
Bell's Asbestos Co., Ld
Bodley, W. H., and Co., Ld
Hulburd Engineering Co
Klinger, R., and Co
Noakes, T., and Son
Smith, S., and Sons

Excavators:
Priestman Bros., Ld
Rose, Downs and Thompson
Whitaker Brothers, Ld
Wilson, J. H., and Co., Ld

Expanded Metal:
New Expanded Metal Co., Ld

Fans and Turbines:
Barry, Henry, and Co., Ld
Buffalo Forge Co
Davidson and Co., Ld
De Laval Steam Turbine Co
Gilkes, G., and Co
Gordon, J., and Co (Leeds)
Günther, W., and Sons
Heenan and Froude
Howes, S.
Keith and Blackman Co., Ld
Lloyd and Davis
Marx, J., and Co
Musgrave and Co., Ld
Parsons, C. A., and Co
Sturtevant Engineering Co.
Thwaites Brothers, Ld
Waddle Pat. Fan & Eng. Co

Feed-water Heaters:
Boby, Wm.
Caird and Rayner
Normandy's Fresh Water Co
Storey, I., and Sons
Weir, G. and J.
Wheeler Condenser & Eng. Co
Wright, Jos., and Co

Feneing:
Baylies, Jones and Baylies
Morton, F., and Co., Ld
Rowell, D., and Co

Filters, Waste Oil:
Wells, A. C., and Co

Fireproof Construction:
British Granite Co., Ld

Flour Mill Machinery:
Turner, E. R. and F.

Forced Draught:
Bumsted and Chandler
Erith's Engineering Co
Horsfall Destructor Co., Ld
Howden, J., and Co
Meldrum Brothers

Forgings:
Clarke's Crank and Forge Co
Cooker Bros., Ld
Darlington Forge Co., Ld
Grantham Crank and Iron Co
Ince Forge Co., Ld
Mills, Exors. of J.
Phillips, J., and Co
Smith, S., & Sons, Saltley, Ld

Foundry Requisites:
Jackman, J. W., and Co

Friction Clutches:
Bagshaw, J., and Sons
Barry, Henry and Co., Ld
Edmeston, A., and Sons
Gimson and Co., Ld

Fuel Economisers:
Clay Cross Co
Hudson Economiser Co., Ld

Furnaces:
Brown, J., and Co., Ld
Deighton's Flue & Tube Co
Leeds Forge Co., Ld
Meldrum Brothers
Rushworth and Livsey

Fusible Plugs:
Nat'l Boiler & Gen'l Insur. Co

Gas:
Dowson Economic Gas Co. Ld

Gas Engines:
Campbell Gas Engine Co., Ld
Crossley Brothers, Ld
Dudbridge Ironworks, Ld
Fielding and Platt, Ld
Körting Brothers
National Gas Engine Co., Ld
Pollock, Whyte and Waddel
Premier Gas Engine Co., Ld
Robey and Co., Ld
Robson, J.
Tangyes Limited

Gauge Glasses:
Branscomb, E., and Son
Butterworth Bros., Ld
Guilbert-Martin
Monerieff, J.
Tomey, J., and Sons, Ld

Gauges:
Hopkinson, J., and Co., Ld
Klinger, R., and Co
Newall Engineering Co., Ld
Schaffer and Budenberg
Smith, Sydney, and Son

Gauge Glass Protectors:
Hulburd Engineering Co
Wallach Bros.

Gear Cutting:
Brown, D., and Sons
Smith, J., and Co

Glass:
Pilkington Bros., Ld

Gearing:
Ahlers, Ad.
Baker, J., and Sons, Ld
Bodley Brothers and Co
Harpers Limited
Jones, George, Ld
New Conveyor Co., Ld

Governors:
Pollock, MacNab & Highgate

Grain Cleaning Machin'y
Boby, R., Ld

Graphite:
Dixon Crucible Co

Grinding Machinery:
Bradley Pulverizer Co
Central Cyclone Co
Fawcett, Preston and Co., Ld
Hardy Patent Pick Co
Krupp Grusonwerk, F.
Phillips, J. W. and C. J.
Roberts Bros

Grindstones:
Rooper and Harris, Ld

Hammers:
Davis and Primrose
Massey, B. and S.
Pilkington, P., Ld
Player, W. and J., Ld
Ross, R. G., and Son
Samuelson and Co., Ld
Tangyes Limited

Handles:
Burley and Son, Ld

Harbour Plant:
Stothert and Pitt

Heating Apparatus:
Bourne Drying & Vent'ng Co
Buffalo Forge Co
Erith's Engineering Co
Körting Brothers
Royles Limited
Simpson, J., and Co., Ld
Sturtevant Engineering Co

Hose:
Merryweather and Sons, Ld
Moseley, D., and Sons, Ld

Hydraulic Leathers:
Rose, Downs and Thompson

Hydraulic Machinery:
Abbot, J., and Co., Ld
Berry, H., and Co., Ld
Fielding and Platt, Ld
Leeds Eng. and Hydraulic Co
Musgrave Bros.
Musker, C. and A., Ld
Rice and Co
Smith, Hugh, and Co
Tannett, Walker and Co., Ld
West Hydraulic Engin'g Co

Hydro-extractors:
Broadbent, T., and Sons
Manlove, Alliott and Co

India-rubber, &c.:
India-rubber & Teleg. Wks, Ld
Moseley, D., and Sons, Ld
St. Helens Cable Co., Ld

Indicators:
Crosby Steam Gage & Valve Co

Injectors and Ejectors:
Arm-trong, J., and Co., Ld
Consolidated Eng. Co., Ld
Green and Boulding
Gresham and Craven
Klinger, R., and Co
Wilcox, W. H., and Co

Inks, Drawing:
Higgins and Co

Inspecting Engineers:
Price, J.
Severn, W. H.

Insurance:
Alliance Assurance Co., Ld
Sun Insurance Office
Vulcan Boiler Insurance Co

Iron & Steel Works Plant
Akrill, C., and Co., Ld
Head, Wrightson and Co., Ld
Wellman Seaver Morgan Co

Iron Buildings & Roofs:
Anderson, D., and Son, Ld
Barrowfield Ironworks, Ld
Boulton and Paul, Ld
Braby, F., and Co
Clyde Structural Iron Co., Ld
Grover and Co
Handyside and Co., Ld
Hemingways, Ld
Hill and Smith
Lysaght, J., Ld
Main, A. and J., and Co
Morton, F., and Co, Ld
Piggott, T., and Co
Renshaw, W. R., and Co
Rowell, D., and Co
Walker Brothers, Ld

Jacks, Ball-bearing:
Maclellan, P. and W., Ld

Jointing:
Bagshawe and Co
Dixon Crucible Co

Laundry Machinery:
Bradford, T., and Co
Summerskles, W., and Sons
Tullis, D. and J., Ld

Lead Machinery:
Wilson, J., and Son

Lifts and Hoists:
Easton and Co., Ld
Sandycroft Foundry Co., Ld
Smith and Stevens
Waygood and Otis, Ld
Youngs

Light:
Wells, A. C., and Co
U K. Lighting Trust, Ld

Lithographers:
Cook and Hammond

Locomotives:
American Locomotive Co
Avonside Engine Co
Boyer Peacock and Co., Ld
Borrig, A.
Burnham, Williams and Co
Dodman, A., and Co., Ld
Hawthorn, Leslie and Co
Hunslet Engine Co., Ld
Kerr, Stuart and Co., Ld
Lowca Engineering Co., Ld
North British Loco. Co., Ld
Peckett and Sons
Vulcan Locomotive Works

Lubricators:
Empire Engineering Co
Hulburd Engineering Co
Rimington Bros.
Stern Brothers
Trier Brothers
Wakefield, C., and Co., Ld

Manganese Steel Castings and Forgings:
Allen, E., and Co., Ld
Hadfield's Steel Foundry Co

Mathematical Instrum'ts
Negretti and Zambra
Stanley, W. F., and Co., Ld
Thornton, A. G.

Metal Perforators:
Barns, W., and Sons

Merchant Iron:
Dorman, Long and Co., Ld
Dunkerley, C. C., and Co., Ld
Farnley Iron Co., Ld
Henderson and Glass
Kirkstall Forge Co
Measures Brothers, Ld
Pearson and Knowles Coal Co

Meters:
Glenfield and Kennedy, Ld

Metals:
Bull's Metal & Melloid Co., Ld
Delta Metal Co
Magnolia Metal Co., Ld
Mond Nickel Co., Ld
Phosphor Bronze Co
Stevenson's Metal Co
Tandem Smelting Synd., Ld
Tungsten & Rare Metals Co

Mica:
Wiggins, F., and Sons

Mills:
Krupp Grusonwerk, F.
Smedley Brothers

Mining Machinery:
Davey, Paxman and Co., Ld
Ransomes, Sims and Jefferies
Sandycroft Foundry Co., Ld
Walker Brothers, Wigan

Model Makers:
Lucas and Davies

Motor Cars:
Hercules Steam Wagon Co
Mann's Patent Wagon Co
Thornycroft Steam Wagon Co

Moulding Machines:
Jackman, J. W., and Co.

Nut Making Machinery:
Haskew Walton Co., Ld

Oil Cans:
Kaye, J., and Sons, Ld
Valor Co., Ld

Oil Engines:
Blackstone and Co., Ld
Campbell Gas Engine Co., Ld
Crossley Brothers, Ld
Cundall, R., and Sons, Ld
Dudbridge Ironworks, Ld
Fielding and Platt, Ld
Gardner, L., and Sons
Hardy and Padmore, Ld
Hornsby and Sons, Ld
Newton Electrical Works, Ld
Pollock, Whyte and Waddel
Samuelson and Co., Ld
Tangyes Limited

Oil Extractors:
Baker's Pat. Appliances, Ld
Haigh, W. B., and Co., Ld
Holden and Brooke, Ld

Oil-gas Apparatus:
Mansfield E., and Sons

Oil Launches:
Vosper and Co., Ld

Oil Mill Machinery:
Rose, Downs & Thompson, Ld

Oils and Lubricants:
Humann and Stern, Ld
Bremner, J. A., and Co
Price's Patent Candle Co
Scarab-Sonneborn Oil Co
Trier Brothers
Wells, The Henry, O Co

Packing, Engine:
Green and Boulding
Hobdell, Way and Co., Ld
Hulburd Engineering Co
Klinger, R., and Co
Kühn, F., and Co
Lancaster and Tonge, Ld
Mossay, D., and Sons, Ld
U.K. Metallic Packing Synd.
U.S. Metallic Packing Co
Witty and Wyatt, Ld

Painting Machine
Wallach Bros
Wells, A. C., and Co

Patent Agents:
Alexander, E. P., and Son
Harris and Mills
Jensen and Son
Redfern, G. F., and Co
Vaughan and Son
Wa'kin, S., Son and Groves
Whitelow, E. T.

Pattern Makers:
Brown, D., and Sons
London Patternmaking Wks

Pens and Pencils:
Gillott, J.
Hardtmuth, L. and C.

Pig Iron:
Clay Cross Co
Lilleshall Co

Pile Drivers:
New Southgate Eng. Co
Simons and White

Piles:
Williams, S., and Sons, Ld

Pipes Iron and Steel:
Clayton, Sons and Co., Ld
Laidlaw, R., and Son
Mechan and Sons
Pigg tt, T., and Co, Ld

Pistons:
Jackson, P. R., and Co., Ld
Lancaster and Tonge, Ld
Lockwood and Carlisle, Ld

Plummer Blocks:
Hunt, R., and Co., Ld
Jardine, J.

Pneumatic Sand Sifter:
Pneumatic Appliances Co

Pneumatic Tools:
Consolidated Pneumatic Tool Co., Ld
Macdonald, J., and Son
Piercy and Co
Ross, R. G., and Son

Powder Coal Plant:
Central Cyclone Co., Ld

Presses:
Taylor and Challen, Ld

Printing & Stationery:
Reveirs, Geo.
Semerce and Sons, Ld

Pulleys:
Bagshaw, J., and Sons, Ld
Crossley, Geo., Ld
Crowther, H., and Sons, Ld
Douglas, Lawson, and Co
Gandy Belt Manufacturing Co
Graham, Morton & Co., Ld
Harvey Limited
Jackson, P. R., and Co., Ld
O'Neill, S., and Sons, Ld
Reid, W., and Co
Smith and Grace

Pulverisers & Quarts Mills
Bradley Pulverizer Co
Central Cyclone Co., Ld

Pump Leather:
Hepburn, Gale and Reid, Ld

Pumps:
Allen, W. H., Son & Co., Ld
Bailey, W. H., and Co., Ld
Batchelor, R. D.
Blake & Knowles Pump Works
Cameron, J., Ld
Carruthers, J. H., and Co
Combe Barbour, Ld
Drum Engineering Co
Drysdale, J., and Co
Evans, J., and Sons
Fleming and Ferguson, Ld
Glenfield and Kennedy, Ld
Gwynnes Limited
Hall, J. P., and Sons, Peterboro
Hathorn, Davey and Co., Ld
Hayward-Tyler and Co
Hughes and Lancaster
Körting Brothers
Lancaster and Tonge, Ld
Mills, Geo., and Co
Mumford, A. G.
Owens, S., and Co
Pearn, F., and Co
Pulsometer Engineering Co
Reader, E., and Sons, Ld
Richards, R., and Co
Simpson, J., and Co., Ld
Tangyes Limited
Thwaites Brothers, Ld
Vauxhall Ironworks Co
Warner, R., and Co
Westinghouse Brake Co
Wilcox, W. H., and Co
Worthington Pump Co

Purchase Hire System:
Lewis and Lewis, Ld
Sykes, H., Ld

Railway Plant:
Askham Bros. & Wilson, Ld
Bagnall, W. G., Ld
Beatson, J., and Son
Birch, J., and Co., Ld
Bolling and Lowe
Cravens, Limited
Darlington Wagon & Eng. Co
Dick, Kerr and Co., Ld
Electric Ry. & Tram Car Co
Fleming and Ferguson, Ld
Fowler,

Fuller, Horsey, Sons & Cassell,
BILLITER SQUARE, LONDON, E.C.
ESTABLISHED 1807.
AUCTIONEERS, VALUERS, AND SURVEYORS
OF
MILLS AND MANUFACTORIES,
PLANT AND MACHINERY,
WHARVES AND WAREHOUSES.
Telegraphic Address—"FULLER HORSEY, LONDON."
Telephone No. 746 Avenue. ns10

Railway Switches and Crossings.
TURNTABLES, WATER CRANES, TANKS, PIPES, BRIDGES, AND ROOFS.
ISCA FOUNDRY and ENGINEERING CO., Newport, Mon.
London Office: 10, Bush-lane, Cannon-street, E.C. (Spl) ns155

Bone Grinding. — The Best
Machine is the Devil Disintegrator, which grinds to powder, granulates, or shreds almost any material. All sizes are kept in stock.—THE HARDY PATENT PICK COMPANY, Limited, Sheffield, England. (Spl) ns13

JOSEPH AIRD.
TUBES & FITTINGS.
GREAT BRIDGE
STAFFORDSHIRE.
JOSEPH AIRD'S PATENT
DOUBLY SECURE FLANGED TUBES
IN THE LARGER SIZES, UP TO
& INCLUDING 12IN. IN DIAMETER,
FOR COMPRESSED AIR,
STEAM, & WATER PURPOSES, MINES,
COLLIERIES, &c.
LONDON OFFICE:
46, QUEEN VICTORIA STREET, E.C.
(Spl)ns 343

Byrne's Patent Friction Clutch.
See Advertisement, last week, page 42.
GIMSON AND CO., LEICESTER, LIMITED,
VULCAN STREET, LEICESTER. ns Y740

C. and A. Musker, Ltd.,
LIVERPOOL.
HYDRAULIC AND ELECTRIC MACHINERY.
See Last Week's Advertisement. ns152

Cranes. — Steam, Electric,
HYDRAULIC and HAND,
of all types and sizes.
GEORGE RUSSELL AND CO., LTD.,
Motherwell, near Glasgow. (Spl) ns179

George Wailes and Co., Engineers and IRONFOUNDERS, 258, Euston-road, N.W., are in a position to UNDERTAKE promptly all kinds of REPAIRS and the MANUFACTURE of SPECIAL MACHINERY to customers' own designs. Castings and Gearing supplied quickly. ns176

Patternmaking of every Description in WOOD; also MODEL MAKING in WOOD and METAL. Send for quotations.
THE LONDON PATTERNMAKING WORKS,
ns353 1, East Hill, Clapham Junction, London, S.W.

Steam and Electric Cranes,
EXCAVATORS, CONCRETE MIXERS, STEAM WINCHES, AND WINDLASSES. (Spl) ns157
JOHN H. WILSON AND CO., Limited, Sandhills, Liverpool.
See Illustrated Advertisement last week, page 28.

Tank Locomotives, 4 or 6 Wheels coupled. Specification and workmanship equal to main line engines.—Apply to R. and W. HAWTHORN, LESLIE and CO., Limited, Engineers, Newcastle-on-Tyne. (Spl) ns2
See Illustrated Advertisement last week, page 27.

Tungsten and Rare Metals Co.,
Ltd., 91, Bleakfriars-road, London, S.E.
TUNGSTEN AND OTHER METALS, AND ALLOYS FOR STEEL MAKERS. ns333
See Monthly Advertisement 4th Dec., 1903.

COALWASHING, SCREENING, AND ELEVATING PLANT.
THE HARDY PATENT PICK COMPANY, SHEFFIELD, ENGLAND. (Spl) ns144

DIAMOND DRILLS,
PROSPECTING TOOLS,
SCHRAM, HARKER and CO., (Spl.) ns175
CANNON STREET HOUSE, LONDON, E.C.

STEEL AND IRON. **FORGINGS** ROUGH OR FINISHED.
HOLLOW CRANK AND OTHER SHAFTS.
Bs167
INCE FORGE CO., LTD., WIGAN.

ROBERT BOBY, LIMITED,
BURY ST. EDMUNDS, SUFFOLK.
PATENT SCREENING MACHINERY
OF ALL KINDS. ns339

PECKETTS' Workmanship and of the Highest Quality.
Built to any Specifications or Gauge. **LOCOMOTIVES.**
PECKETT & SONS, Atlas Locomotive Works,
BRISTOL. (Spl.) ns9

STONE BREAKERS.
BAXTER'S PATENTS ARE THE BEST.
Spl. ns155
W. H. BAXTER, LTD., LEEDS.

THE EDWARDS
PATENT AIR PUMP.
For Illustrations see Dec. 18th (page 69). (Spl) ns26
3 and 4, CROWN COURT, OLD BROAD STREET, E.C.

YARROW'S
WATER-TUBE BOILERS.
SEE ILLUSTRATED ADVERTISEMENT APPEARING THIRD ISSUE OF EACH MONTH.
(Spl) ns28
POPLAR, LONDON.

NOW READY.
THIRD EDITION, Revised and Enlarged. PRICE 7s. 6d. NET.
DEPRECIATION OF FACTORIES,
MINES, AND INDUSTRIAL UNDERTAKINGS, AND THEIR VALUATION.
By EWING MATHESON, M. Inst. C.E.
THIS EDITION HAS BEEN THOROUGHLY REVISED TO DATE, and such subjects as MUNICIPAL TRADING, LOCAL LOANS, ELECTRIC UNDERTAKINGS and PREFERENCE PARTNERS, have been included for the first time. Additional information has also been added under the heading GOODWILL, ADVERTISING, STEAMERS, FAMILY INTERESTS, RATING OF RAILWAYS AND MINES, and MORTGAGES.
LONDON: E. AND F. N. SPON, LTD., 125, STRAND. ns131

IN PREPARATION.
Gleanings from Patent Laws of ALL COUNTRIES.
By W. LLOYD WISE, F.R.G.S., Assoc. Inst. C.E., Fellow of the Chartered Institute of Patent Agents.
(Spl) ns351
London: F. WISE-HOWORTH, 46, Lincoln's-inn-Fields, W.C.

MARINE ENGINEERS
Should make a point of sending for our SPECIAL PAMPHLET Illustrating and Describing our Latest Design of
LONG STROKE VERTICAL MARINE FEED PUMP for HIGH-PRESSURE BOILERS.
(Spl.) ns331
WORTHINGTON PUMP CO., LD.,
153, QUEEN VICTORIA ST., LONDON, E.C.

NEWMAN, HENDER & CO., LD.
WOODCHESTER, nr. STROUD, GLOS.
Makers of HIGH-CLASS STEAM and WATER FITTINGS.
COCKS AND VALVES OF EVERY DESCRIPTION.
On Admiralty Lists. On War-office Lists.
Speciality—ASBESTOS-PACKED COCKS and FITTINGS, &c., to Admiralty requirements. Bs134

HARPERS' LIST.
PAGES XIV.—XV.
THREE WEEKS AGO.

CONTINUOUS & POLYPHASE
MOTORS.
MATHER & PLATT, LTD.,
(Spl) Bs161
SALFORD IRONWORKS, MANCHESTER.

Gas Engine, Stockport, Equal to new (about 30 B.H.P.), Shafting 2½in., Couplings, Plummer Blocks, Hangers, Brackets, Pulleys, FOR SALE, cheap, all or part, in consequence of being replaced by large electrical installation. — BUSSEY, Sports Manufacturers, Peckham. P938

Locomotive Tank Engines for IMMEDIATE DELIVERY. New 12in. by 18in., four-wheels coupled; new 14in. by 20in., six-wheels coupled; copper fire-boxes, brass tubes; other sizes in advanced state of progress; workmanship equal to main-line engines.—The AVONSIDE ENGINE COMPANY, Bristol. Y852

Machine Tools Ready. — We carry in Stock and Progress one of the largest assortments of LATHES, PLANES, DRILLS, SCREWERS, MILLERS, &c., as supplied to the leading Engineering, Loco., and Government Shops. Complete workshops fit up on shortest notice.
PITT MACHINE TOOL CO.,
Yorkshire Machine Tool Works, Alma Foundry and Providence Foundry, Liversedge. Telegrams or Letters, Pitt, Liversedge. 'Phone 38, A B C and A1 Codes. 169

Mersey Railway.—For Sale by PRIVATE TREATY.
14 VERY POWERFUL LOCOMOTIVES, 19½in. and 21in. cylinders, built by Messrs. Beyer, Peacock and Co., and Messrs. Kitson and Co.
85 FOUR-WHEELED CARRIAGES, 1st, 2nd, and 3rd Class, fitted with vacuum brake and Pintsch's gas equipment. Also a complete PINTSCH'S GAS-MAKING PLANT.
SPARE PARTS for LOCOS., WHEELS and AXLES, BOILER TUBES, FIRE BARS, &c.
For priced catalogues apply to
R. BOWMAN SMITH,
Traffic Manager,
Mersey Railway,
548 James-street Station, Liverpool.

One New 12in. by 24in. High- CLASS HORIZONTAL ENGINE with automatic expansion.—H. COLTMAN and SONS, Loughborough. 1976

Planing Machine for Sale, slightly damaged, easily repaired, will plane 9ft. long, 4ft. wide, 2ft. high, strong, heavy pattern machine; will sell cheap, immediate disposal.—Apply, COOPER and NEPHEWS, Berkhamsted. 2037

To be Sold. A Bargain.—The TWO Temporary FOOTBRIDGES on either side of London Bridge, consisting of lattice steel spans, 12ft. wide, two being 158ft. and eight being 147ft. long, in all 700 tons; together with about 225 squares of 3in. planking, 30,000ft. super of galvanised corrugated iron, 30,000ft. cube in wnole and half timbers, 4000ft. run new steel rails, 50 lb. to the yard; 4000ft. of 5in. by 7in. Ogee guttering, original cost £35,000; to be sold for £10,000 cash; these spans are bolted in sections capable of carrying a rolling load of 200 tons, suitable in every way for light railways or footbridges. — For particulars apply to PETHICK BROS., Vauxhall Bridge Office, Westminster, S.W 2032

An Engineering Firm is Open to TAKE UP, DEVELOP, and PUSH SPECIALITIES and PATENTS in STEAM ENGINES, PUMPS, &c., upon terms to mutual advantage.—Address, 150, Engineer Office, 33, Norfolk-street, Strand, W.C. 160

(ESTABLISHED 1888).
LONDON DRAWING AND TRACING OFFICE.

Drawings	Photo-Copies (or Sun Prints)	Models of Works	Perspectives
Tracings	Litho. Printing	& Buildings.	Diagrams

Telegrams—"Dividitors, London." 96, GRAY'S INN ROAD, HOLBORN, W.C. (Adjoining Holborn Town Hall.) (Spl)ns89 Telephone—No. 1011 Holborn.

Books, Scarce and Out of Print, on Iron, Steel, and Metallurgy, Engines and Boilers, Chemistry, Architecture, Building, Railways, Electricity, Mining, Tables, Calculators, Trade Journals, &c. State wants. Catalogues free. 100,000 BOOKS for SALE and WANTED.—BAKER'S, Booksellers, John Bright-street, Birmingham. ns77

W. H. SEVERN, A.M.I.C.E., M.I.M.E.
CONSULTING AND INSPECTING ENGINEER AND ENGINEERING VALUER.
REPORTS AND VALUATIONS of Locomotive Stock and Machinery, for Rating Appeals, and general purposes.
INSPECTION.—Locomotives, and all Classes of Machinery and Plant, Rails, and Structural Steel Work, &c.; Mining, Dredging, Contractor's Plant. 20 Years' experience.
PALACE CHAMBERS, 9, BRIDGE STREET, WESTMINSTER, LONDON, S.W. ns 365

A Long-established Firm of Engineers and Merchants, having extensive connection throughout the whole of Great Britain, particularly in the Midland and Northern districts, DESIRE to REPRESENT MANUFACTURERS of modern high-power GAS ENGINES. Highest references given and required.—Address, 1805, Engineer Office, 33, Norfolk-street, Strand, W.C. 1805

"Made in England." — Well- ORGANISED German Firm, of high standing and ample means, disposing of excellent business connections all over Germany and other continental countries, DESIRES to TAKE UP the SALE of PROVED ARTICLES (patented ones preferred). First-class references asked and given.—Address, P922, Engineer Office, 33, Norfolk-street, Strand, W.C. P922

New Patent Boring Chuck for the Measuring of Drills with Morse Cones. The temporary PATENT is to be SOLD cheap. This chuck is suited especially for boring machine manufacturers.—Address offers to U. C. 1323, Haasenstein and Vogler, Cologne. 1856

Portland Cement. Guaranted unadulterated. As supplied to Works of the Admiralty and War Office. Tensile strain 570 lb. per square inch 7 days. —Apply, J. S. ARMSTRONG, 81, Southfield-road, Bedford Park West. 2023

ROLLER BEARINGS FOR SHAFTING.
A NEW ENTERPRISE—TO MEET A WANT.
Efficient durable English-made Roller Bearings at same price as ordinary Plummer Blocks. Save 50 per cent. of power—no increase in first cost.
ABSOLUTELY THE BEST BEARING IN THE MARKET.
Send for full particulars—
EMPIRE ROLLER BEARINGS CO., Ltd., Westminster, S.W., and King's Lynn. 2053

Bright-Drawn Steel Bars, for use in Automatic Screw Machines and Turret Machinery Large stocks of current sizes for immediate delivery at special Prices.—ALFRED HERBERT, Ltd., Coventry. A3

Castings for Engines, Electric MOTORS, PRINTING MACHINES, TANK PLATES, &c.
SIMKISS and KNIGHTON,
California Foundry, Parliament-street, Derby. 1160

Castings. — For Good Sound MACHINERY CASTINGS, in green or dry sand or loam, up to 15 TONS in weight, and MACHINED if required, apply to ROSE, DOWNS, and THOMPSON, Limited, Old Foundry, Hull. Special quotations for quantities. Y935

Engineers and Manufacturers who are interested in the latest and most perfect development of Oil Separators for Exhaust Steam and Water Softeners, WRITE for our NEW PAMPHLET (free) to BAKER'S PATENT APPLIANCES CO., Limited, Melrose-street Works, Scarborough. 1660

John Spencer and Sons, Limited, NEWBURN STEEL WORKS, NEWCASTLE-ON-TYNE.—Springs, Buffers, Steel Castings, Forgings, Tool Steel, Files, &c., Siemens Steel Blooms and Bars.
London Office: 32, Victoria-street, Westminster S.W. J5

Johnson and Phillips, Telegraph AND ELECTRIC LIGHT ENGINEERS.
14, Union-court, E.C. Works: Charlton, Kent.
Makers of Machinery, &c., for complete equipments of Cable Factories and Vessels. Electric Light Apparatus of all kinds. Arc Lamps. Electric Transmission of Power Plant. Cable and Wires. G1821

Johnson and Phillips' Cables— Vulcanised India-rubber, as supplied to H.M. Admiralty. Paper insulated for Traction and Power installations. Cable laying Contractors to the principal Corporations.
Works: Old Charlton, Kent. G1685

MINING MACHINERY
STONEBREAKERS, CRUSHING ROLLS
(for fine or coarse crushing),
BALL MILLS, SCREENS, TROMMELS, FINE CRUSHERS, ELEVATORS and CONVEYORS, DRIVE CHAINS, and SPROCKET WHEELS
of every description.
Apply— Y973
J. S. HALL, Midland Ironworks, NEWARK-ON-TRENT.

Steam Launches, &c.—The Davis ENGINEERING and LAUNCH BUILDING CO., Ltd., St. Helen's Works, Abingdon, is prepared to CONTRACT for the BUILDING of High-speed LAUNCHES, TUGS, STERN WHEELERS, &c., in Steel or Iron. Makers of high-pressure, triple, and compound condensing engines, marine, or locomotive boilers. Several Launches, Machinery, &c., in Stock E1704a

Wheatley Kirk, Price and Co.
(Established 1860).
MECHANICAL AND ELECTRICAL VALUERS, AUCTIONEERS AND ARBITRATORS.
Our average Annual Valuations exceed £2,500,000
Special Rates for Periodical Valuations.
Annual Valuations and Reports of Electrical Undertakings, Tramways, &c., in conformity with the Acts, a Speciality.
46, Watling-street, Queen Victoria-street, London, E.C., and Albert-chambers, Albert-square, Manchester.
Telephones: 5077 Bank, London; 3818 Central, Manchester
Telegrams: "Indices," London; "Indicator," Manchester. ns306

Engineering Partnerships.— FIRMS of good repute, OPEN to ADMIT PARTNERS, or desirous of SELLING OUTRIGHT, also GENTLEMEN wishing to JOIN or PURCHASE ESTABLISHED BUSINESSES, are invited to communicate, in strict confidence, with the undersigned, who have always a considerable number of such openings in most branches of the Profession. References exchanged. — WHEATLEY KIRK, PRICE and CO., 46, Watling-street, Queen Victoria-street, London, E.C.; or Albert-chambers, Albert-square, Manchester. ns351

Fine Modern Car Building WORKS, occupying a covered area of 8½ acres, built regardless of cost. 25 acres available for future extensions, equipped for turning out 700 cars per annum, canal adjoining and railway siding into premises, for SALE OUTRIGHT.—Apply, WHEATLEY KIRK, PRICE and CO., 46, Watling-street, London, E.C. P958

Engineer's and Founder's BUSINESS. Full work; new machinery and premises; room for extension; close main line. Established 20 years. Proprietor retiring. Part purchase money can remain.—FOUNDER, *Morning News*, Bridgwater. P939

For Sale, a Factory Fully- EQUIPPED for the Manufacture of Explosives, and licensed for nitro-compounds and nitro-glycerine. Distance from London about 25 miles, and from nearest station about 2 miles. It stands upon land 125 acres in extent, a portion of which is at present temporarily sub-let; held on remainder of lease with 34 years to run. The land is supplied with water, and most suitable from its contour for the purposes of such a factory. It is furnished with substantial factory buildings, magazines, mounds, testing ranges, &c., and contains the usual plant in complete state of efficiency for making gelatinised and other explosives. In addition there is a well-built and commodious manager's house on the premises. Immediate possession can be given.—Apply, Messrs. SLAUGHTER and MAY, Solicitors, 18, Austin Friars, E.C. 1881

For Sale, by Private Bargain, WESTMUIR BOILER WORKS, Parkhead, Glasgow, adjoining the North British Railway, and as presently occupied by Waddell and Co., boilermakers
The works are quite new, and fully equipped with the most modern machinery (including pneumatic and hydraulic plant) for boilermaking and general work.
Extent of ground, 1 acre; annual feu duty, £25.
For further particulars apply to JAMES STEWART LAMB, C.A., 105, Bath-street, Glasgow; or Russell and Dunlop, Writers, 54, West Nile-street, Glasgow, the latter of whom have the titles. 2 35

For Sale, Old-Established BUSINESS of GENERAL ENGINEERS in London, having up-to-date tools and good connection. Price £2000.—Apply, in first instance, to P940, Engineer Office, 33, Norfolk-street, Strand, W.C. P940

Haigh Park Estate, Leeds.—For SALE, VALUABLE SITES, specially adapted for Factories, Warehouses, and Engineering Works, with Railway and Canal facilities with each Plot.—Apply to T. E. MARKS, Haigh Park Estate Office, City-square, Leeds. P873

In Good Railway Centre, near to coal, about three-hour run from London, a substantially-built FACTORY, containing about 17,000 square feet of floor area. Rent £95 per annum.—Apply, W. A. BRACKETT, Estate Agent, 21, The Square, Retford. 2034

Telegrams: "Detect, London"; "Value, Nottingham."
Telephones: 4962 Holborn, London; 107 Nottingham.
HUNT, SONS AND BRIGHT,
ENGINEERING VALUERS & SURVEYORS,
373 to 378, Birkbeck Bank Chambers, Holborn, London, W.C., and
48/50, London Road, Nottingham.
VALUATIONS AND PERIODICAL INSPECTIONS OF ENGINEERING AND ELECTRICAL WORKS, MANUFACTORIES AND MACHINERY.
PARTNERSHIPS NEGOTIATED. BUSINESSES BOUGHT AND SOLD.
Correspondence strictly confidential. ns354

Mr. John Price, M.I. Mech. E., INSPECTOR of RAILS. Railway rolling stock; iron and steel of every description. Postal and telegraphic address, PRICE, Workington. Established 1874. P775

Henry Smith, Basingstoke, ENGINEERS and IRON TRADES VALUER and ARBITRATOR.
46 years' practical experience. Engineering Businesses and Partnerships always on hand and wanted. O13a

VALUATIONS.
Wood and Newland,
42, SPRING-GARDENS, MANCHESTER.
VALUERS and AUCTIONEERS to Engineering and Allied Trades. ns110
Partnerships and Transfer of Businesses negotiated.

Parliamentary Deposit of Plans.
NOVEMBER, 1903.
ROBT. J. COOK AND HAMMOND,
LITHOGRAPHERS, &c.,
2 and 3, TOTHILL-STREET, WESTMINSTER.
(Established in Westminster 1860). ns332
Tele. No. 551 Victoria. Tele. Add.: "Cartoons, London."

Largest Register of Waterside FACTORY and INLAND PREMISES, WHARVES, WAREHOUSES, BUILDING LAND, &c., to be LET or SOLD, in numerous localities, obtained free of LEOPOLD FARMER and SONS, Auctioneers and Specialists in Waterside Premises, 45, Gresham-street, E.C., and Kilburn, N.W. ns 347

Warehouse, 78, Salusbury-road, Kilburn, N.W. 12,500 sq. ft., on two floors; cartway; good light. Rent £270. Price £3250. Ground rent £30. Also No. 76, area 5000 sq. ft.; rent £140; price £1700; ground rent £15; new buildings; offices arranged as required; immediate occupation.—Plans and particulars on application to HARNETT and BROTCHIE, 58, Salusbury-road, Kilburn, N.W. 1863

The Tool and Machinery Register contains entries of over 3000 lots of Machinery, suitable for all trades. Specimen copy 2d., post free. Annual Subscription, 8s., post free. YOU SHOULD SEE ONE.—Write: THE REGISTER, Britannia Works, Colchester. ns56

Work Undertaken.—Peter HOOKER, Ltd., Blackhorse-lane, Walthamstow, London, ENGINEER and IRONFOUNDER, having large premises and modern plant, will be pleased to undertake the MANUFACTURE of any class of MACHINERY in large and small quantities. E2

Printed for the Proprietors by SYDNEY WHITE at the Office of Gresham Revenue, Grayston-place, Fetter-lane, and published weekly by him at THE ENGINEER OFFICE, 33, Norfolk-street Strand, in the Parish of St. Clement Danes, in the County of Middlesex.